THE GUNNER:

SHEWING

The whole PRACTISE of

ARTILLERY:

With all the Appurtenances thereto belonging.

TOGETHER WITH

The making of extraordinary *Artificial Fire-workes*, as well for Pleasure and Triumphs, as for Warre and Service.

WRITTEN

By ROBERT NORTON, *one of his late Majesties Gunners and Engeniers.*

---

m. acut

LONDON

Printed for *Humphrey Robinson*, and are to be sold at the Three Pidgeons in St. *Pauls* Church-yard, 1664.

TO

THE EMPERIALL MAIESTIE OF GREAT BRITTAINE, FRANCE, AND IRELAND,

KING CHARLES.

ALmighty God hauing made your *Maiesty* Soueraigne ouer many ſtrong Nations, naturally Martiall, and Artificially exerciſed in Armes: Yet if they want Diſcipline (though many) they are but few; and though elſe ſtrong, yet therefore weake. Your mighty Kingdomes alſo being ſtrongly ſituated by Nature, Intrenched about with a broade Dike the Seas, Palliſadoed with Rockes and Sands, Sentinelled with ſtrange ſetting Tydes of Ebbes and Floods, Defended by frequent Stormes and Tempeſts, highly Inritched with Fertillity of Nature, Furniſhed plentiouſly with all manner of Matterialls fitting the felicity of Mans life vpon Earth, both for time of *Peace* and *Warre*; So that nothing can ſeeme to bee more wiſhed for, if Induſtery bee vſed; but eſpecially, if Correſpondency bee found in a good and due temper betweene the Head and the Members, as perfect Obedience and Seruice from the Members to the Head, and entire loue and care from the Head to the Members, for their good and ſafety. *Gunnes* your Maieſty hath, but want *Gunners*, becauſe they want Reſpect and Encouragement: let

Occaſions be ruled with Reaſon, VVarrs managed with Diſcipline, Iudgement, and Pollicie: Let ſtubborne Offendors be puniſhed, Deſeruing Men preferred, Eminent Places not granted for Fauour to inſufficient Men or Strangers, hauing honeſt Subiects farre more able to performe the Seruice: So we ſhall all make Holiday to ſerue our *God*, obey our *King*, and enioy Gods bleſsings beſtowed vpon vs, *euery Man Eating his Grapes vnder his owne Vine*, without feare of forraigne Enemies: To conclude then, nothing can be wanting, Men, Money, Meanes nor Proſperity; when the God of Order hath ſetled ſuch a congruity. Now that your Maieſty may the better be prouided hereafter of vnderſtanding *Gunners* to manage your Artillery, the powerfull Regent of moderne VVarre: I haue endeuored in this *Practice of Artillery*, to ſupply their wants the beſt I can, not doubting but in ſhort time it may worke good effect therein: If your *Maieſty* will be gratiouſly pleaſed to countenance theſe few Lines vnder your Royall Patronage. My wrongs and diſcouragements hath hitherto hindred the publication hereof: VVhich, if your Maieſtie would be pleaſed to referre to be examined and relieued accordingly; It will then appeare I had cauſe to ſpeake; And I ſhould be againe encouraged for greater and further Seruices hereafter: So moſt humbly crauing pardon for my boldneſſe, proſtrating my ſelfe at your Sacred Feete, as by Oath and Duty bound, will euer remaine,

Your moſt Faithfull and Loyall

Subiect and Seruant,

ROBERT NORTON.

To Mr. *Robert Norton*, and his *Practiſe of Artillery*.

VVHen firſt I knew the difference of Time,
and ſeuerall *Climates* of the Worlds round Globe,
I then thought *Artiſts* fitteſt Men to clime
to Honor, and to weare the Golden Roabe;
But now theſe Times doe differ from that Time,
Strangers reſpected are By Courtiers crime.

Then when I knew the Seas, my whole delight
was how to trimme a Shippe prepar'd for Warre;
But all was vaine, till *Gunners* Skill and Might,
with practiz'd Forces all excells ſo farre;
Let *Sea-men*, *Land-men*, all *Men* truly know
That *Gunners* Art's of Subſtance, not of Show.

The *Land-man*, he moſt boldly makes Approch
with Horſe and Foote, with Sword, and Shield, and Speare,
But all were vayne, he neuer could encroach,
if *Gunnes* and *Gunners* ſhould be wanting there;
Therefore ſuch Artiſts ſure t'were beſt to cheriſh,
And expert *Gunnered Engeneers* to nouriſh.

For proofe whereof, let euery Artiſt view,
why ſuch Men ſhould not to preferment mount,
Peruſe this Booke, its Lynes, and Fgures true,
ſo may he finde the difference of Account
Twixt th'*Engliſh*, and the *Dutch*, *Norton*, and *Borre*,
Then giue our owne their due without demor.

Moratur in lege.

But *Norton*, I haue been ſomething to bold
to Paraphraſe vpon thy Worth and Quality,
Becauſe I want ſufficient, to vnfold
them, and th'Ingenious Workes reality;
Let this ſuffice, thy praiſe will ſhew it ſelfe,
It's worth the *Golden-Fleece*, the *Indian* Pelfe.

Captaine Iohn Butler.

A Due to the Author, his Worke and Worth.

SInce mongſt all Nations Warre *it ſelfe doth ſhowe,*
It behooues Man Warres *Weapons for to know,*
Who here may learne the Gunners *ayming Arts,*
Which thy free induſtry to all imparts;
The fitteſt ſubiect now it is by farre,
At theſe times, when ſuch Rumors are of Warre,
And filles the Eares, and Courages awake,
Goe on then, and to Thee this glory take,
That he that reades theſe things which thou doſt write,
May know a Gunners *part, though he nere fight,*
And know Warres *chiefeſt* Engines *vſe and ſtrength,*
In Bore, Cilinder, Axis, *and in* Length,
In Touch-hole, Carriage, Ward, *in* Shot *and* Charge,
Of Fire-workes *in briefe thou ſpeakſt at large;*
French, Spaniſh, Dutch, Italian, *vaile your Cappes*
To Nortons *skill, in* Mars *his* Thunder-claps.

Iohn Rudſtone *a Louer of the Artes* Mathematicall, Theorick *and* Practick.

To his good Friend Maſter *Robert Norton*, on his *Practiſe of Artillery.*

I Told you Friend, before your Booke I'de write,
But not Idolatrize with Poetick ſpright,
Doing our loues much wrong, in little right.

The Times neceſſity, and each Studious minde
Will make it prayſe it ſelfe, which you ſhall finde
By'ts oft impreſſion, th'Art being here refinde.

Yet (iuſtly I confeſſe) I haue been ſhowne
Bookes that ſell well, yet not for what's their owne,
But for Commendators before them knowne.

And this integrity Commands me ſay,
That to the Trueth thou ſhewſt the righteſt way,
For Young Artiſts, and here the Old may ſtay.

For here th'are ſatiſfied with ſmall diſpence
Of Purſe, or Braines, of Skill the quinteſſence,
Drawne from the Antick Artiſts excellence.

I know rich Iewells may themſelues commend,
Which be ſuch Bookes (that for the publique end)
With Iudgement written are; So thine good Friend.

Richard Robinſon.

In the due Honor of the Author Maſter *Robert Norton*, and his Worke.

PErfection, if t hath euer been attayned,
In Gunners *Art, this Author hath it gayned,*
By Study and Experiences, and he
The Fruite of all his Paynes hath offered Thee,
A Preſent well befitting this our Age,
when all the World is but a Martiall Stage:
Let ſweeter Studies lull a ſleepe and pleaſe
Men, who preſume ſecurity, but theſe
Thy Labors practiz'd, ſhall more ſafely guard
Thoſe that foreſee the Danger, th'other bar'd
This benefite: Wee Soldiers *doe imbrace*
This Rare and vſefull Worke, and o're the face
Of all the World, let thy Fames Echo ſound,
More then that roaring Engin, *and redound*
To th'Honor of our Nation, that thy Paynes
Tranſcends all former, and their glory ſtaines.

Captaine Iohn Smith,
HVNGARIENSIS.

A Table of the Contents.

Definitions Page 1
Demands 2
Maximes 3
Theoremes 5
Arithmetick 17
Geometry 23
Perspective for Heights, Breadths, Distance, and description by Plat. 30
Chap. 1. Of the generall definition of Artillery. 35
Chap. 2. Of the first invention of Gunnes and Gunpowder. 37
Chap. 3. Where Ordnance were first vsed in these parts. 40
Chap 4 Of what formes and fashions Ordnance were first made. 41
Chap. 5. Of former forraigne foundings of Ordnance, and of French Ordnance. 42
Cha. 6 Of founding legittimate Ordnance, with a Table, and Venetian Ordnances 44
Chap. 8. Of Bastard Peeces with their Table of Names, Waights, and Measures. 44
Chap 9. Of extraordinary Peeces and a Table of their Names, Waight, and Measures, and of the Drakes, and their Inuentor. 46
Chap. 10 Of English Ordnance distinguishing into 4 kindes, and those into sorts, beginning with the Cannon. 51
Chap. 11. Of the Cannons of Batterie in particular, or of the first kinde, and the sorts thereof. 54
Chap 12. Of Culuering the second kinde, and the sorts thereof, 55
Chap 13 Of Canon Periors the third kind and their sorts. 57
Chap. 14. Of Morters the fourth, and the square Murtherer Pettar, &c. 59
Chap. 15. Of seuerall Wayes to preuent a Pettard. 64
Chap. 16. With what Instruments to breake Pallissadoes, Grates, Perculliſſes &c. 65
Cha 17 To dispart a Peece true bored. 66
Chap. 18. Of certaine faults in forraigne foundings of Ordnance 67
Chap 19. Of the Ligue or Aligation of Mettalls for brasse Ordnance. 69
Chap. 20. Of Earthes or Powders for Moulds to cast them. 70
Chap 21. Of making Moulds for the founding of Ordnance. 71
Chap 22. Of the Place, Measure, and vse of the Trunnions. 72
Chap. 23. Of Examining if a Peece of Ordnance be well made, and of what kinde and sort it is. 74
Chap 24 To tertiate Ordnance, and finde what Powder they can beare. 77
Chap 25. To finde if her Soule lye in the middle of her Body. 88
Chap. 26. To dispart a Peece, whose Soule lyeth Horizontally and paralelly awry in her Body. 81
Chap 27. To dispart a Peece, whose Soule lyeth vertically and paralelly awry in her Body. 82
Chap. 28. To dispart a Peece, whose Soule lyeth awry Trauersly and not paralelly in her Body 83
Chap. 29. Of the Large and Large Lyne in wry bored Peeces. 85
Chap 30 To finde the Weight of any Shot by the Diameter Arithmetically. 87
A Table of the Weightes and Measures of all Mettalls and Stones named 90
Chap. 31 To finde the same Geometrically and Instrumentally. 91
A Table to mount any Peece by the Inch Rule as well as by the Quadrant, to any Degree assigned. 93
A Table for euery quarter of an Inch height, for Weight of Iron, Leade, and Stone Shotte. 94
The Description and vse of my Gunners Scale. 94
Chap. 32. Of the Rule of Calibres, or anuent for each Shotte. 95
Chap 33. Of the Gunners Quadrant. 95
Chap 34. A new Deuise of the Authors, to Leuell, Mount, or Imbase a Peece of Ordnance by a Staffe or Halbert. 96
Chap. 35. To finde the right Range of a Peece for euery Mounture 97
Chap. 36. To finde the Leuell vnder the right Range. 98
Chap. 37 To finde the Leuell vnder the Crooked Range. 99
Chap. 38. Of the violent Crooked and Naturall Course of a Shotte. 99

An

An excellent Dyagram of Randons. 99
A Table of Randons, and a Table of ſecant Ranges and their vſes. 100
Chap. 38. *To load a Peece Gunner-like.* 101
Chap 39. *Whether the longer Peece will out-ſhoote the ſhorter of equall height.* 102
Chap. 40 *Of ſhooting Myra Commune, or by the Mettall.* 103
Chap 41. *Of ſhooting by the Axis or deſpert.* 104
A Table of right Ranges. 105
Chap. 42. *Of ſhooting vpon the aduantage.* 105
A Table of dead Ranges. 106
Chap. 43. *To amend a fault at the ſecond ſhott.* 107
Chap 44. *To make an aſſured good ſhott.* 109
Chap. 45. *To make Ladles and Spunges for each Peece.* 110
Chap 46. *To make Bridges ouer Riuers for the Army and Ordnance.* 112
Chap. 47. *How to defend a Fortreſſe beſieged.* 113
Chap. 48. *To make an extraordinary ſafe Counter-battery.* 114
Chap. 49. *Reaſons of failing of a ſhott.* 115
Chap. 50. *To conduct a Myne to blow vp a Place, and of Galleryes* 116
Chap 51. *Of the Windles, Martinet, and* Archimedes *endleſſe Screw.* 118
Chap. 52. *To draw Ordnance to the top of ſteepe and rough Mountaines.* 120
Chap. 53. *How the Trayne of Art ſhould be ordered in a March.* 121
Chap. 54. *To draw Ordnance by labour and Pyoners if Cattell want.* 122
Chap. 55. *Extraordinary priuiledges of the Trayne in Marching and lodging.* 124
Chap 56. *To waigh a ſunke ſhipp and Ordnance ſurrounded.* 125
Chap. 57. *To make Cartredges to loade Ordnance without Ladle.* 127
Cha. 58. *The names of the parts of a Peece.* 128
Chap. 59. *The making of a Field Cariage in proportion.* 129
Chap. 60. *To make Wheeles and Axtrees for Cariages for Ordnance.* 130
Chap. 61. *To make Candleſticks, Blinds, Sauſſedges, and Sauſſons to hide.* 132
Chap. 62. *To plant Ordnance in ſecret and double Battery.* 133
Chap. 63. *To plant Ordnance where the Rampart is to narrow, and earth wanting.* 134
Chap. 64. *To make a Battery with Peeces interred.* 135
Chap. 68. *How the Ordnance are to be placed at the time of ioyning of 2 Armies in Battalia.* 138
Chap. 69. *How to fill vp a wet Dyke, to approach a Breach made.* 139
Chap. 70. *Of the Gunners ſeruice in generall.* 140
Chap. 71. *Of the difference of our Engliſh meaſures and waights, from forraigne Nations of Feet and Pounds.* 141
Chap. 72. *Of making of Salpetre, whether Naturall or Artificiall.* 142
Chap. 73. *Of Gunpowder, and the making of the vſuall ſorts thereof.* 144
Chap. 74. *Of the making Matches to fire Ordnances, Traynes, Artificiall Fireworkes &c.* 147
Of Fireworkes *for Tryumph.* 149
Of the Rocket *and* Structures, *&c.* 150, 151, 152
The deſcription of certaine Wheeles of Artificiall Fireworkes, &c. 153
How to make a Rice, and a Caſtle, and a Trunke of Artificiall Fireworkes. 154
How to make flying Dragons and Rockets that will runne vpon a Lyne and returne againe, &c. 155
How Artificiall Fireballs and Granadoes are to be formed & loaded with their mixtures. 156
How to conuoy or direct Fire into a place aſſigned, or vpon the Enemie in an Aſſault. 157
Of the Pyked Trunke Gunne, and quadruple Barrell-Peeces. 157

I hope

I hope with *Scapes* that alter not the ſence,
The friendly Readers will for Loue diſpence:
And thoſe that are in th'Errata here expreſt,
His louing Pen will mend, and thus digeſt.

Page	*Line*	
4	8	For bodies more, *r. bodies moue.*
18	13	in the totall for 2536, *r.* 2356
Ib.	40	for 31701, *r.* 31941, &
Ib.	43	for 49861, *r.* 1492101
19	*vlt.*	for the 2 and carie, &c. *r. the* 2 *and* 2 *times* 6 *make* 12, *ſet downe the* 2 *and carie* 1, *&c.*
Ib.	10	for 149861. *r.* 149210
20	*vlt.*	for files and flank, *r. Front*
21	1	for Front multiply, *r. Flank deuide.*
Ib.	3	for Front, *r. Flank*
22	10	for double, *r. double* 3 *and haue* 6
Ib.	22	for $\frac{2}{100}$, *r.* $\frac{31}{320}$.
Ib.	23	for thirty, *r. three hundred.*
23	7	for $\frac{8}{31}$, *r.* $\frac{8}{2}$
27	22	for ſubſcribed, *r. circumſcribed*
29	36	for B to D, *r. B to C.*
30	41	for parts the, *r. parts giue the.*
31	1	for 8000, *r.* 24000.
Ib.	2	for 66 *r.* 200.
32	1	for 20, *r.* 29.
35	16	for neere ioyned, *r. neere or ioyned.*
Ib.	26	for and both the ancient, *r. and the ancient.*
39	19	for, For that now, *r. That now.*
39	27	for Ayming, *r. Ayme at.*
42	24	for, For I ſay, *r. I ſay.*
44	3	for $\frac{1}{24}$, *r.* $\frac{1}{20}$ and in the Table vnder for deg. *r. heights,* and for de, *r. lengthes.*
45	30	and 31, for leuelleth, *r. leuell.*
53	13	for 1 $\frac{1}{2}$, *r.* 17 $\frac{1}{2}$.
54	42	for 143, *r.* 250.
67	43	for afterwards, *r. forwards.*
69	24	for 16, *r.* 100.
78	22	and 23, for ordinary Culnering, *r. leſſned Culnering.*
94	*vlt.*	for Table following, *r. former Table.*
97	39	for right range, *r. dead range.*
105	17	in the Table for 424, *r.* 524.
106	35	for 2000, *r.* 1000.
142	33	for to diſolue, *r. to vapour.*
144		Betweene lynes 5 and 6, *r. The* 73 *Chapter.*
146	6	for aſle, *r. adde.*
Ib.	27	for topped, *r. Tapped.*
Ib.	31	for top, *r. tap.*

THE PREFACE TO THE courteous Readers.

THE Art and Practiſe of Artillery (the ſubiect of this preſent Treatiſe) being as Bianco ſaith, the Crowne and Palme of the Warres and Millitary diſcipline, teaching how to ouerthrow & demolliſh Cities, Towns and Caſtles, to ſinke Shippes, and inhumanely euen to teare the life and ſoules from the bodies of innocent men, women, and children, viet armis, to get the poſſeſsion of the Goods and Lands that rightly belong to others for our ſelues: it may therefore at the firſt bluſh ſeeme to be abſolutely contrary to all Chriſtian charity. But when on the contrary wee come to finde, that Warre is euen the Mother and Nurſe of Peace, the Rampart of Iuſtice, and the Law of the World; yea, the Scriptures affirme that War was a thing authorized by God himſelfe, who commanded Saul thereby to deſtroy the Amalekites, and not to ſpare either Man or Beaſts, &c. As alſo that Warre was exerciſed in Heauen by the good Angels againſt the bad: So likewiſe hath Nature armed the Beaſts of the Field, the Fowles of the Ayre, and the Fiſhes of the Sea, and as it were by inſtinct, taught them with their Hornes, Tallents, Teeth, and Finnes, to fight one with another, to defend themſelues, and offend others. But more eſpecially, when wee truly conſider, how that without Warre and Warlike Amonition, and Diſcipline, no Kingdome or Common-weale can long ſubſiſt in Peace, or be able to defend it ſelfe, nor offend their Enemies: the caſe will then ſeeme to be much altered. Theſe then, and the great preparations, the Martiall pollicies, cruell ſtratagems, and deuilliſh inuentions of the common Enemies of our King and Country (whereby they intend, and with malicious greedineſſe daylie endeuour to deſtroy vs all with our Wiues, Children, and Families, to the end to poſſeſſe our goods and lands.) Theſe I ſay may more then incite vs now (though late) to learne, know, and vſe to practiſe this principall and potent part of Warre, ſo that thereby with Gods aſsiſtance (alwayes making him on our

ſide)

ſide) we may become able and proſperous in reſiſting thoſe their intended miſchiefes, and breake the necks of their curſed deſignes, and ſo conſequently eſcape thoſe eminent and threatned dangers.

Now for as much as the moſt proſperous effects haue vſually ſucceeded and moſt vigorouſly preuailed, when ingenious inuentions and religious politique diligences hath beene ioyned with Armes (good Pollicie farre exceeding Force.) Therefore for the better vnderſtanding of the ſequent diſcourſes, we ſhall doe well firſt to conceiue that euery materiall thing is either to be lineally deſcribed, or elſe intellectually vnderſtood by ſome proper Figure, or apt word, name, or definition, which properly belongeth thereunto: For as euery Art hath certaine Rules and Principles (to preceade) without the knowledge of which no man can attaine vnto a neceſſarie perfection for practiſe thereof, vnleſſe hee firſt endeuour to learne (rather by Reaſon then by Roate) what each part thereof is, with the Name and Nature of each Member and part of it (without which firſt obtained) And I ſay, let a man take neuer ſo much paines and ſtudie therein, he ſhall but in vaine puſle his braines and not benefitting himſelfe. The neglect of which is the cauſe why many (otherwiſe well affected to Art) doe ſo fruitleſly beſtowe both their Time, Labour, and Coſt, to no purpoſe, often condemning the Art as too hard for them, when (God knowes) the onely cauſe is their diſorderly progreſſe in the ſtudie and practiſe thereof: And I dare ſay for the Gunners Art, although it be deepe (euen able to ſpoſe the knowne parts of Naturall Philoſophy, Arithmetick, Geometry, and Perſpectiue, each of which her handmayd is) yet by the Definitions, Theorems, and Queſtions contained in my former Booke extant, Of the Art of great Artillery, and in this of the Practiſe of Artillery, I hope the willing may (with ſmall paines ioyned with orderly and diligent practiſe) wade ouer this Ocean ſafely ſatisfied; neuertheleſſe that if Archimides (were he now liuing) without experience and long practiſe therein) with ſundry tryals he could not poſſibly demonſtrate the manifold varieties of that Mixthelicall arch or circuit of the Bullets courſes, compounded of violent and naturall motions, and receiuing infinite diuerſities, according to the ſeuerall proportions and temperatures of the Powder, length of the Peece, matter of the Shot, Mounture, and Mettall, lead on by Experience the Miſtris of all Arts, Action being the beſt Tutor: Much leſſe I (the moſt vnable of many) who haue endeuoured herein more to reſpect a few experimented truthes, then many Rhethoricall imbelliſhments of words. Therefore neither can, or will, I preſume to

aſſume

assume so exact perfection to bee herein: although I haue endeuoured to auoyde the apparant errors of Santbech, *the erronious principles of* Tartaglia, *the false rules of* Rosselli, *the time-ouerworne directions of* Cataneo, *the grosse allowances of* Collado *for Mountures & Imbasings, but especially the arch false proportionality taught in Mr.* Smiths Art of Gunnery, *now entituled the* Complete Souldier (*many of which are by Mr.* Diggs *and my selfe noted, at the end of my said Booke of the* Art of great Artillery, *and a number more there are most intollerable false, For the positions which hee there inserteth, are fit onely to leade young Gunners out of the right path and way they should walke in, with a seeming easinesse by tying (as he would) such things to Arithmeticall works and proportions, as are directly contrary, and of another nature, as a small tryall will manifest, which in cruteste, I thought fit to aduertise the Reader of: But as* Palingenius *saith,*

Friuola si fuerint fundamina tempore paruo
Deficiet, quiquid super his fabricare volimus.

Some men also may imagine because the figures heerein are many of them, the same that were cut for Captaine Vffanoes *Booke of* Artillery, *Printed at* Frankford, *that therefore I haue onely translated the same. I confesse the figures most of them being good, and he for this and the most part he hath written of this practise, being the best of any the Authors that I euer read: yet had I onely translated him, I should but little haue helped English Gunners: their Measures, Waights, Ordnance, and Powder so much differing from our English, as in their places I haue shewed, it would not haue been* operæ pretium *so to haue done: But that I haue from him and other Authors made choise of some things, and refined & applied others for our benefits, I am not to denie; nor that the Figures are many of them his that I haue herein written vpon, which was by reason of their goodnes, faireness, and cheapenes; for the Figures, had they beene cut of purpose in* England, *would haue made these Bookes too deare for Gunners, for whose good they were originally destined, wherein I haue roughly endeuoured in well meaning, which if it be well taken, I shall be therewith well satisfied, and rest readie to explaine whatsoeuer shall herein seeme difficill.*

Now that this my Treatise for the practise of Artillery, may the more currantly proceede, & be the playner to the vnderstanding and satisfaction of the Reader, I held it necessarie first to shew by certaine Definitions, Demands, Axioms, & Theoremes *(besides those in my former Booke) called the* Art of great Artillery *(which I wish euery young Gunner to*

peruſe alſo with diligence) the names, natures, and operations of ſuch things as are neceſſarie to be knowne, vſed, and done in the Practick part thereof, without which it were impoſsible to conclude any thing well, and as it ought to be. Therefore as in the Warres *of our age, there is no* earthly force *that can more command the Fortified, or reſiſt the aſſaulting* Enemie *then great Ordnance duly vſed. So the* Gunners *therefore ought to endeuour to vnderſtand theſe ſo well, that they diſcharge them not in vaine. Firſt, in regard of the great expences of Amunition thereby caſt away: Secondly, leaſt thereby they fruſtrate the wiſhed ſeruice. Thirdly, in laying themſelues and their Companies open and vndefenced to the* Enemies *Forces, which will (in them) encreaſe valour, and in your ſelues terrour, thereby alſo deſeruing to purchaſe great blame and diſhonour from the hands of their Commanders, with the loſſe of the Princes fauour, and vtter ouerthrow of their owne preferment euer after. Wherefore ſeeing that ſuch fruitleſs diſcharging of Ordnance in the time of ſeruice, is ſo great an inconuenience, and happeneth moſt commonly for want of knowledge, or ready meanes to direct the Peeces preciſely to the marke; I haue thought it worthy my labour therein to ſhew Artificiall meanes (to ſuch as are deſirous to learne) how to know, direct, and prepare the Peeces committed to their charge; ſo, that in time of neede they may bee aſsured to make their Shotts take good effect, onely by applying themſelues to vnderſtand and practiſe theſe fewe things following.*

THE

THE PRACTICE OF ARTILLERIE.

The first Definition.

PLACE is the ſpace enuironed with the interior ſuperficies which containeth and enuelopeth each thing, limited in euery ſence with the proper dimenſions of the thing contained. *Euclid. def 5. lib. 1.*

As the Place of my Body *hath the ſame dimentions that my* Body *hath.*

Definition 2.

Emptie, is the Place in which no corporall thing is contained. *Ariſt. lib. 4. tex. 57.*

But nature abhorring Emptineſſe hath left no place for it in this ſublinar world.

Definition 3.

Rare, Is that which vnder large dimenſions hath but little matter. *D. Tho. 3. part. qua. 77.*

Contrariwiſe Thicke or Groſe hath vnder little meaſure much matter for Thickneſſe and Thinneſſe are ſuch bodies conſequent qualities, as haue much or little matter vnder their dimenſions.

Definition 4.

To *Increaſe*, is to inlarge the former dimenſions.

Increaſing cemmeth of changing of quantity from little to more which may bee without changing the figure, As the Gnomon *added to the* Square *increaſeth it, yet the figure remaineth ſquare ſtill.*

Definition 5.

To *touch*, is to haue their extreames together.

As touching is proper onely to a Body, ſo is it alſo proper vnto all Bodies, for it is reciprocall with the quantity of a Body. *Ariſt. li. 4. Phiſ. text. 23.*

Definition 6.

To *Moue*, is to tranſport from one place to another, or to turne into the ſame, or change the quality.

Becauſe

Cap. 7. lib. 8. Phiſ. *Becauſe that which we intreate of is Materiall, and depends vpon an Action of Nature, we will define changing of* Place *to be made by mutation from the* Place, *or from the* Grandure : *as that which rarifieth, extendeth, and changeth place by increaſing more, and one thing may mooue another by remooning it, or by driuing it away.*

Definition 7.

To *remoone*, is to thruſt out of the *Place* without expulſion or driuing it away.

Ariſt. lib 7. Poyſ. ber. 10. *So to carry, to lead, to put from, to preſſe downe, to draw, and ſuch like mouings are things in that manner ſaid to be remooued without being driuen, caſt, or ſhot away.*

Definition 8.

To *Expell* is to Remooue by driuing out, darting, or ſhooting away, which is either ſlowly and eaſily, or ſwiftly and rudely.

Eodem. *Either as the* Ramme *Engine doth ſlowly, or as the* Cannon *doth ſwiftly driue away.*

Definition 9.

Swiftneſſe, is a force that doth much in a little time.

In Lache. *As any thing that is tranſported a long diſtance in a little ſpace of time, is ſaid to be ſwift.*

Definition 10.

To *Mount*, is to raiſe or eleuate vpwards towards the Skie aboue the Horizon: To *Embaſe* is to deſcend, or depreſſe vnder the ſame, downewards, from the Heauens ward.

Theſe are termes depending vpon the diſpoſition of Men.

Difinition 11.

Vnder the name of *Artillery* we comprehend all *Armes of Fire.*

As Gunns *and* Fireworkes, *&c. for Warlike ſeruices.*

Demand 1.

THat the Superficies of the Columne of the Peece bee perfectly round, or elſe regularly ſquared, eſpecially at the thickeſt of the Mettall at the *Mouth* and *Breech.*

Demand 2.

That the *Axis* of the *Bore* or Cauity (of the Peece giuen) be ſtraight from the one to the other end of the Columne, and equidiſtant and paralell from the concaue Circumference thereof, at all places ſo farre as the Shot deſcendeth into the ſame, being of equall wideneſſe.

Demand 3.

That the Peece giuen to be prepared haue her ordinary Cariage and Platforme giuen, ſo right and duly fitted, as will neither cauſe nor ſuffer the Peece

Peece deliuering and reuersing to start from the leuell or direction giuen.

Demand 4.

That the Shot keepe his course so from his due resting place in the cauity of the Peece vnto the *Poynt Blanke*, or end of the right range thereof, so as that the centre of it be alwayes in the Axis of the Bore (supposed infinitely to proceede) without any sensible declination from the same. The said Bore being part of the way of the said shot, and the directer of the residue of the course of the same.

Demand 5.

That the *Point Blanke*, or right line or Range be that point in the Axis of the *Bore* imagined to proceed and bee infinitely continued vnto that place where the Centre of the Shot shall in his course sensibly begin to decline from the said continued imagined Axis downewards.

Demand 6.

That the visible right line made or imagined to passe from the *Breech* of the Peece to the Mouth of the same vpon the highest ring or superficies of the Mettall (she lying on her Cariage and Platforme) be called the *Middle lyne* of the Peece.

Demand 7.

That the visible right line made or imagined to passe from the *Breech* to the *Mouth* vpon the surface of the Mettall vertically ouer the Axis of the Bore of the same Peece (she lying vpon her *Cariage* and *Platforme* giuen) be called the *Large lyne* of that Peece.

Demand 8.

That the shortest distance between the verticall plane of the Axis of the Body of the Peece, and the verticall plane of the Axis of the Soule or Bore of the same Peece, taken vpon the *Baseringe* at the Breech thereof (for the cariage Peece and Platforme giuen) be called the Large of that Peece.

Maximes of Naturall Philosophy necessary to be first knowne.

1 EVery motion in the world endeth in repose.
2 All motions are made vpon some quantity.

3. Euery simple Body is eyther *Rare* and *Light*, or else *Thicke* and *Heauy*, and according to these differences it is Naturally carryed towards some part.

4 The world hath high or vpwards, and low or downewards, and the Low dependeth vpon the influence of the high.

5 The rare bodies mount, the fier, more then the Ayre. The thicke and grosse bodies descend, the *Earth* more then the *Water*.

6 The lighter are more moueable then the heauier.

7 Nothing worketh Naturally in that which is wholly like or wholly dislike, but in that which is contrary to it, and more feeble.

8 The *Forme* working, is ayded by the *Qualities*, as the *matter suffering*, which suffereth by the quantity.

9 *Nature* is extreamely curious, as well of her perfection, as of her conseruation;

ſeruation; and then when all things conſpire.

10 Aſwell the Action that commeth from the Agent, as the *Paſsion* from the Patient hath proportion.

11 Accident taketh his vnity from the Subiect, and goeth not from one thing to another.

THEOREM. 1.

Euery Corporall thing repoſeth in its naturall place.

LIght bodies more towards the heauens vpward, and heauy bodies towards the Earths centre downewards, each Body is light or heauy, if it be heauy, it will then moone downewards; if light vpwards. Now the circular motion is neither vpwards or downewards, therefore no Motion can be circular but by violence.

THEOR. 2.

Motion may be made in any place within the Moones Orbe.

Euery thing that is within the Lunar Orbe may make motion or change,

THEOR. 3.

Before any thing moueth towards its Naturall place, from its firſt being, it goeth ſtretching vnto the naturall meaſure.

Neither augmentation nor dimiuution is made but onely by changing of the qualities or formes, for the qualities alone (incontinently following new generation) doe cauſe eyther ſtretching or ſhrinking. And true it is, that in ſuch Mooüings as tend vnto the entire ruine of the formes, the iuſt demenſions are not found to be but either greater or leſſer according to the quantity agitating moſt forceably therein, and ſo it mooueth moſt violent and longeſt.

THEOR. 4.

Nature admitteth no Emptyneſſe.

Nature purſueth and entertaineth perfection as much as is poſsible. Now the perfection of Motion is the end thereof; namely the repoſe, that the ſimple Body would find eyther vpwards or downwards in all places: therefore in the Elementary vniuerſe, they affect their repoſe either vpwards or downewards. So there is not by Nature any ſuch thing as vacuity, for the auoiding of which, nature maketh heauy things mount, and light things deſcend, whereby marueilous things are performed. As we may ſee by our Pumps, which make water aſcend as high as the clouds, and by the Spirituallis the ayre is retayned beneath. And diuers other effects ſeeming ſo miraculous to ſuch as ſee them as they cauſe thē to wonder therat. For whence commeth it that a veſſell of Marble fild with water, when the water commeth to be frozen into yce, that it break the ſame though a foot thick: but that the water thickneth therby, and ſo breaketh the volume of the ordinary quantity thereof, the cauſe preceading, the effect followeth. So alſo a

narrow

narrow necked bottle filled with liquor, and turned the bottome vpwards, yet retaine the liquor from running out: becauſe Ayre cannot enter therein, to fill the place, whereupon we may iudge that the Law of fulnes is more generall, and precedeth that of the Mouing of ſimple Bodies.

THEOR. 5.

Euery Body hath a place.

A poynt which cannot be marked in eſſence, not hauing any parts, is no Body, and therefore is contrary to the Hypotheſes. But a Body hath place of dimenſions, ſo if the ſurface of the body which approacheth on all ſides, and toucheth euery where, tying the ſuperficies to cloſe the body, it is then in ſuch a place as hath the very ſame dimenſions within, that the body hath without, or elſe there muſt be emptineſſe, which by the precedent were abſurd.

THEOR. 6.

A Body rarifying its ſelfe, the place thereof increaſeth as the Body increaſeth.

As a Body of Earth that then contained one ſolide foote in meaſure bee made water, which adding thereto, one other ſolid foote, the place alſo muſt encreaſe, from one to two ſolid feete, or elſe it hath not the ſame iuſt dimenſions within, that the body hath without, and ſo it is not the place of that body of water; ſo if the place alſo were greater then the body filled, there muſt in that place be emptineſſe betweene it and the body, which were abſurd: therefore the place encreaſeth as the Body rarifying doth.

THEOR. 7.

Two Bodies cannot be together in one and the ſame place.

If ſeuerall Bodies could be together, all the members of one ſame Body might alſo haue one and the ſame place, and each part might one fall into the range of the other, which were to take away from the quantity, the true Nature thereof, and which by its eſſentiall property ſetteth out the parts ſeuerally one from another: Neuertheleſſe that ſome ſleight apparances haue ſeemed to yeeld a ſuſpition that it might be ſo: As take a veſſell full of aſhes finely ſifted, and you may put into the ſame as much water alſo as would without the aſhes haue filled the veſſel. So by the veſſell full of aſhes, and the ſame veſſell full of water, two Bodies ſeeme to bee in one place: So into a glaſſe full of water you may put in many peeces of money before it runne ouer. And likewiſe an yron heated red hot, is it not fire and iron together, and ſo two bodies in one place?

No, for theſe are but illuſions: for the firſt veſſell fild with aſhes (that are very volatyle) part flyeth, and the reſt hath place doubtleſſe, but the water ſwelleth by meanes of its vnctuouſnes receiued, vnto a roundnes aboue the brims of the veſſell as much as the true body of the aſhes is ouer, and yet ſpilleth not. And ſo in the glaſſe likewiſe the ſupreame ſurface of the water ſwelleth as much aboue the brims of the glaſſe as the Body of the peece of money hath receiued place. And laſtly, ſeeing it is but the forme of fire or quality of heat liuely lent vnto the yron, it can not be truely ſaid, that

 therefore

therefore two bodies are together therein, for there is but one matter vnder those two formes hauing but one quantity, so neyther are two bodies mingled in one Place, nor penetration of dimensions, which is impossible: from whence the ingenious practizer may extract admirable effects.

THEOR. 8.

A place filled cannot receiue another Body in without expelling the former one.

Amongst Bodies, some are hard and robust, and some are soft and tender, so that if vnto a soft body in a Place, a hard body should enter, it would violate the dimensions of the soft body. And seeing *Plato* himselfe said there was no solid things, but terrestiall, this difficulty were fit to be resolued. *Plato* then spake not of Mathematicall solidity, or of shorter or longer dimensions, but of that rather which is called firmenesse or hardnesse: as we vsually say stone to bee more solid then wood, and yron to bee more solid then stone: also if we haue onely respect to the demonstration, then there is as much solidity in a Cubick foote of Butter, as in a Cubick foote of Marble stone: And so if the Ayre or Water doe giue way to Bodies that are more firme or heauie, it is not because they are lesse solid, but that they are more moueable and lighter. Therefore if a vessell full of Ayre or Water had an other hard or heauy Body put thereinto without expulsing of the Ayre or Water proportionally. Then two Bodies would be in one place, which is a thing by the former impossible.

THEOR. 9.

The Resistance of the Moued proportioned to the Mouer, furthereth the Motion.

The *Action* and *Passion* must be proportionalls amongst themselues: It were but vaine for the Agent to giue a strong stroke, if the thing that is to be moued receiue it not: And it cannot receiue it well, if there be not contrariety, (which resteth in the Resistance) for so in the obiect that should obay entirely, there would be no Action at all: For nothing worketh that is wholy vnlike. Contrariwise, also if the Resistance were wholy like, or equall to the force of the stroke, there would bee no Motion: For nothing worketh in that which is wholly like, wherefore there must be a proportion exercised betweene the Mouer and the Resistance, to attend the entire impression of the stroke: for if the Resistance be greater then the force of the stroke, the Chaser shall be chased: for of two Aduersaries, the most violent is the Master. Besides, the more an Action is continued, the greater it is. Therefore the longer time the Mouer toucheth the Moued in expulsion, the more the force of the Mouing impressed, is entertained, and longer doth it endure. And this is the reason why the Powder, Wadd, and Shotte, are driuen into a Peece, but with meane force: For if the Shott bee too loose put in, it would not well receiue the fury of the Powder enflamed, and the force of the blowe will be but weake. And when the Shot goeth in too stiffe, or is forced in too hard, or the Powder ouer-rammed, then the Powders Cornes being thereby broken, will bee cloyed so close, that it will blowe much of the force thereof out of the Touch-hole, before the Shott bee discharged:

Max. 7. El. Artil.

By the same,

charged: But if the Shot were ouall or too high, and being forced in, doth ſtick by the way; it breaketh the Peece, and cauſeth often lamentable and dangerous effects, without performing the expected ſeruice.

THEOR. 10.

Fire taking the Powder, of neceſsity the Shot muſt be driuen forth, and the Peece diſcharged.

At the moment of the inflamation of the Powder, the Peece muſt neceſſarily ſhoote off, and diſcharge the Shot, for the Powder is then in his laſt power to be enflamed, and the Fire taketh in an inſtant. Now that which is burned is rarified, and ſo extends it ſelfe (*Fire* being the rareſt of the *Elements*) but being ſo blocked vp within the concaue ciillnder of the chamber, that it is impoſſible to extend it ſelfe, vnleſſe it remooue the ſhot which occupyerh the place it muſt extend into (for penetrate the Mettall at the Breech and ſides it cannot) Nature then otherwiſe abſolutely commands this extention by the perduction of this new forme of fire. Wherefore from a Naturall violence, and from a force vnto which all things conſpire, and nothing can reſiſt, the ſhot is chaſed, and the peece diſcharged: whereby wee may ſee how Philoſophy and the knowledge of Natures workes, may guide vs to admirable inuentions, The impoſſibility of the penetration of dimenſions and the neceſſity of this fierie generation, when the Actiue forces are vnited to the paſſiue, this hath lead our predeceſſors by the hand to the fabricke of the fearefull Machyue the Gunne beyond all that euer the Art of Man could thinke vpon.

THEOR. 11.

The Bullet begins to flye before the perfect firing of the Powder.

The Powder is not perfectly fired, vnleſſe it be all on fire; now before the forme taketh into the matter (to giue it that being) and to change the nature thereof. Namely, from the firſt rudiments of being, the Matter rarifieth, for the qualities of the Agent preceadeth. Therefore the Place augmenteth, which cannot be vnleſſe the ſhot quit the place: wherefore it beginneth to ſuffer before the inſtant of perfect firing of the powder; for that depart is ſo ſodaine, that ſometimes a great part of the powder goeth out whole and vnfired, which could not be if it were perfectly enflamed, and therefore the greateſt inflammation maketh the greateſt force.

THEOR. 12.

The force of the ſtroke dependeth on the ſwiftnes of the Courſe.

To *Strike* is a matter of Mouing, as is the *Time* & the *Quantity* or the diſtance vpon which it is made, which if the time be ſhort wherein it is carryed home a farre diſtance, then it is called *Swift*: Therefore the ſhorter the *Time* is, the *ſwifter* and *ſtronger* is the ſtroake; Now to *Moue* more is to act more in corporall things, and the more quicke the *Action* is, ſo much the ſtronger. Wherefore according to the meaſure of the *Agents motion*, the ſwiftneſſe of the courſe, the ſtroake is reckoned ſtrong. This is the *Enginieres Helicon* from whence the moſt of their ſtrong *Engins* are drawne, the great-

neſſe of the *diſtance* is nothing if the *Time be long*, nor the ſhortnes of the *Time* if the *diſtance be ſhort.*

THEOR. 13.

There can be no mouing in Action made more violent then with a peece of Ordnance.

The volume or extent of the rarefaction being ten times as much when it becommeth fire as it was when it was earth, Fire being ten times more rare then *Earth*: and of all Natures *Agents* the fire, and of all the *Qualities* *heat* carryeth away the prize for violence, ſeeing the generation of fire in the *Powder* is momentary. Therefore the time of the rarefaction is extremely ſhort, as being of one onely inſtant, if any moment before that generation begin not to driue out the Bullet, the ſtroake muſt then be extreamely violent, ſeeing that the diſtance is very great in reſpect of the ſhortneſſe of the *Time*, vnto which we may adde the quicknes of the flame, which is ſuch, that it will not ſtay here below the leaſt part of time but will flye away.

By the 5. Max.
By the 4. Theor
Ariſt. 2. Meteor

THEOR. 14.

The longer the Chaſe of the Peece the ſtronger the ſtroake.

The generation of this fire being made in an inſtant, the rarity ariueth at once, the violence preſt to chaſe out the ſhot, the flame flyeth making it iſſue out, and the Ayre to come in to preuent emptineſſe, and all as it were in an inſtant. Therefore the longer the Chaſe of the Peece is (being fortified and loaded accordingly) the more effectuall ſhall the Action be, and the ſtroake the more violent, whereby it commeth to paſſe that long *Culuerings* carry further then great *Canons* although with leſſe powder: yet the force is better entertained by their greater length and better fortification to endure the full charge of powder.

By the tenth Theoreme.

THEOR. 15.

A Peece reuerſeth when it diſchargeth.

When the *ignition* beginneth at the bottome of the concaue of the Peece, at the *Touch hole*, the peece reuerſeth at the inſtant of the rarefaction, the vent it can find, being onely forth of the *Touch-hole*, beateth backe vntill the ſhot be gone out. And this maketh a Peece Mounted to ſhoote from alow vpwards, to reuerſe more then vpon the leuell or from aloft downewards: for that the Shot which is heauy, and conſequently violent in his naturall deſcending when it is forced vpwards, it reſiſteth more then either ſhot downewards or leuell; and ſo the more the waight of the Bullet reſiſteth, the force that driueth out the ſhot, which at laſt it is conſtrained to obey and to yeeld the more to the reuerſe. But the Mettal ſuffereth the more when it is reſiſted, as ſome men cauſe it by making a Rampart behind the breech of the Peece, againſt which it may ſtay, thereby to augment the force of the ſhot. From whence we may gather that the impreſsion of Reuerſe is onely whileſt the ſhot is within the Peece: beſides the *Touch-hole* being made neere the bottome of the concaue doth not onely angment the reuerſe more then if the *Touch-hole* were in the midſt of the powder, or rather more forwards whereby

whereby the powder would fire together in the lesse time, and little or none goe out vnfired, reuerse lesse, and make the fury of the Shot the greater: And this maketh the small Pistolls so pierced, to out shoot those that haue their touch-holes peirced at the bottome of their bores.

THEOR. 16.

A Peece of Ordnance shooteth further in a right line, from a low vpwards, then from aboue downewards, except Perpendicularly.

To the shot made vpwards, there is greater resistance of the bullet, but when a shot is made downewards, the force doeth not onely worke, but the waight of the shot also by it's naturall heauinesse, the bullet easily descends from the strait line, falling vnder expectation; whence it commeth, that the right Range is further in Mountures, then in any Imbasure, for this proposition is not to be vnderstood so at the going out of the shot, (for all right Ranges, are all equally strait;) neuertheless, that it is shorteſt shooting from aloft downewards, and longest vpwards, and the leuell being the meane betweene them both.

THEOR. 17.

There are three chiefe most materiall and efficient causes of the greater violence of any shotte made out of great Ordnance, *viz.* the *Powder*, the *Peece*, and the waight of the *Bullet*.

THEOR. 18.

Powder is compounded of three Principles, or Elements, *Saltpetre*, *Sulpher*, and *Cole*, whereof *Saltpetre* is it that giues the chiefest violence.

THEOR. 19.

Albeit *Saltpetre* bee indeed the onely, or most materiall cause of the violence; And that Powder commonly found most forcible, that is richest of *Petre*, yet is there a certaine proportion of Perfection of these three Components. And that in such sort, as if you adde more or lesse Petre, the violence shall abate.

THEOR. 20.

Although Powder bee also the most efficient cause of the force and violence of any shotte, yet is there such a proportionall charge of Powder to bee found for euery seuerall Peece, in regard of the proportion of her charged and vacant *Cylinders*, as giuing more, or lesse, then the same proportionall charges, it shall diminish, and not increase the violence of the shotte.

THEOR. 21.

If any two Bullets of equall quantitie, but vnequall waight, bee let fall from any loftie place to the Horizon, the more weightie, shall euer fall the more swiftly: albeit, not porportionally to their weight; which Axiome is indeed erronious, albeit, a great Philosopher hath auerred the same.

THEOR. 22.

If two equall Bullets of different waight, be shot out of one and the same

Peece directly to the Zenith, both Bullets being of maſſie mettall, and charged with one quantity and kinde of Powder, the lighter ſhall alwayes outflie the heauier. But ſuch kinde of Bullets they may bee charged with all, as the heauier ſhall outflie the lighter, although they be both diſcharged with the ſame Peece, and quantity of the ſame Powder.

THEOR. 23.

There is ſuch a conuenient waight to be found of the *Bullet*, in reſpect of the *Powder* and *Peece*, as the Bullets mettall being either heauier or lighter then that waight, ſhall rather hinder then further the violence or farre range of the ſhot.

THEOR. 24.

There is ſuch a conuenient Proportion to be found of the length of euery *Peece* to his *Bore* or Bullets Diametre in reſpect of the *Powder*, and waight of the Ball, as either encreaſing or diminiſhing that proportion it ſhall abate alſo, and hinder the violence of the ſhot.

THEOR. 25.

This proportion exactly found in any one *Peece*, doeth not hold in all other, and yet the difference and alteration is ſuch, as may be reduced to rules certaine.

THEOR. 26.

Beſides theſe three moſt materiall cauſes of violence, the Randons alſo and different Mounts of Peeces, cauſe a great alteration, not onely of the farre ſhooting of all Peeces, but alſo of their violent Batterie. And albeit the different alterations are very intricate and ſtrange, yet haue they a *Theoricke* certaine.

THEOR. 27.

There are alſo many other Accidentall alterations happening by reaſon of the winde, the thickneſſe or thinneſſe of the Ayre, the heating or cooling of the Peece, the different manner of charging by Ramming faſt or looſe the Powder, by cloſe or looſe rouling or lying of the Bullet, by the vnequall recule of the Peece in his Carriage or deformitie of the Axtree, with diuers other ſuch like, whereof no rules certaine can be preſcribed, to reduce theſe vncertaine differences to any certaine proportions: but all theſe are by Practiſe, Diſcretion, and Iudgement to bee conſidered, and vniformely guided and performed in their beſt perfection.

THEOR. 28.

Any Peece mounted 90. grades aboue the Horizon, throweth his Bullet moſt violently immediatly after the diſcharge, and then the motion groweth ſlower, till the Bullet be come to his vtmoſt Altitude, and then by Perpendicular falling, encreaſeth by little and little, his ſwiftneſſe againe, euen till it come to the Horizon. But at all orher Randons, it falleth not ſo out.

THEOR. 29.

Albeit in the ſubtiltie of *Geometricall* Demonſtration, no part of the Bullets violent

violent motion, can bee truely auerred a right or direct line, saue onely the Perpendicular: yet in these experiments *Mechanicall*, That first part of the violent motion (I meane so farre as the peece is said to carry *Point-Blanke*) being so neere the direct, is, and may well be termed the direct line. As all water leuels are accounted in all Mechanicall operations, the perfectest leuels and directest lines. Albeit the subtiltie of Geometricall Demonstration, doeth finde them not right or direct, but Curue or Circular.

THEOR. 30.

When any Peece is mounted directly to the Zenith. Then doth his motion violent (being in that scituation directly opposite to the naturall) carry the *Bullet* in a perfect right line, directly vpward, till the force of the violence be spent, and the Naturall motion haue gotten the victorie. And then doeth the Naturall returne the *Bullet* downe-ward againe, by the very same perpendicular line. And so is the whole motion of the *Bullet* in this case a very direct perpendicular to the Horizon.

THEOR. 31.

But if any peece bee discharged vpon any Angle of Randon, albeit the violent motion contend to carry the *Bullet* directly by the line Diagonall; Yet the perpendicular motion being not directly opposite, doeth though vnsensibly, euen from the beginning by little and little, draw it from that direct and Diagonall course. And as the violent doeth decay, so doeth the naturall encrease: and of these two right lined motions, is made that mixt Curue Helicall Circuit of the *Bullet*.

THEOR. 32.

Any peece therefore discharged at any Mount or Randon, first throweth foorth her *Bullet* directly a certaine distance, called of some Gunners their *Point-Blanke Range*, and then it maketh a Curue declining Arke, and after finisheth either in a direct line, or nigh enclining towards it.

THEOR. 33.

The further that any peece shooteth in her direct line, commonly called *Point-Blanke*, the deeper also she pierceth in her battery, if the bullet bee not of substance brickle or frangeable.

THEOR. 34.

The more ponderous a *Bullet* is, the more it shaketh in Battery, albeit, it pierce not alwayes so deepe, as the lighter or lesser shot conueniently charged.

THEOR. 35.

Any two Peeces of Battery Ordinance, charged with one kinde of bullet, and shot into one Rampire of massie vniforme kinde of Substance, shall euer make their profundities of piercing proportional, to their leuel Ranges Horizontall; and if they be discharged, either leuell or at one grade of randon, and at like distance.

THEOR. 36.

Any two Peeces of Battery, discharged into any Rampart, of vniforme massie

massie substance, shall euer make their piercing depths proportionall to their lines Diagonall, albeit these Peeces be discharged from different Randons, so as they batter at like distance.

THEOR. 37.

As *Archimides* line Helicall or Spirall, is made by the direct motion of a point carried in a right line, while that right line is Circularly turned as Semidiameter vpon his Circles Center: So is this Artillery Helicall line of the bullets Circuit created onely by two right lined motions, becomming more or lesse *Curue* according to the difference of their Angles, occasioned by the seuerall Angles of the Randon. Whereupon by demonstration Geometricall, a *Theoricke* may bee framed, that shall deliuer a true and perfect description of those *Helicall* lines at all Angles made betweene the Horizon and the Peeces-lines Diagonall.

THEOR. 38.

These direct or Diagonall lines, are alwayes longest when the Peeces Axis is directed to the Zenith. And alwayes as the Peeces Axis declineth more and more to the Horizon. So doe the Diagonall lines grow shorter, and at the leuell Horizontall, shortest of all.

THEOR. 39.

These direct lines Diagonall, albeit they encrease in length at euery grade of Randon from the Horizon to the Zenith, yet is not their encrease vniforme or proportionall, either to their degrees of Randon, or Horizontall Ranges, nor yet to their Circuits or Altitudes, and yet such as may be reduced to a *Theoricke* certaine.

THEOR. 40.

The middle *Curue* Arks of the bullets Circuits, compounded of the violent and naturall motions of the bullet, albeit they be indeed meere Helicall, yet haue they a very great resemblance of the Arkes Conicall. And in Randons aboue 45. they doe much resemble the Hyperbole, and in all vnder the *Ellipsis*: But exactly they neuer accord, being indeed *Spirall* mixt and *Helicall*.

THEOR. 41.

Any Peece discharged at any one Randon with like bullets, and seuerall charges of powder, shall make both their lines Diagonall, and Curue Circuits of different longitude, but the Curue Arkes shall alwayes bee as Parallels, and their Longitudes proportionall to their lines Diagonall.

THEOR. 42.

The last declining line of the *Bullets* Circuit, albeit, it seemes to approach somewhat to the nature of a direct line againe, yet is it indeed still *Helicall* and mixt, so long as there remaineth any part of the motion violent. But after that is cleane spent, the rest of his course to the Horizon is direct, and Perpendicular, and a perfect right line indeed, which is best discerned in those Grades of Randon, which are betweene the Zenith and the Mount or Randon Æquorizontall.

THEOR.

THEOR. 43.

This declining line doth alwayes make a greater and greater Angle with the Horizon, As you raiſe the Peece to a greater Mount, till you come to the Mount Æquorizantall, about which point the ſame declining line becommeth Perpendicular before the *Bullet* fall to the Horizon.

THEOR. 44.

The Horizontall Ranges in all Peeces mounted from the Horizon toward the Zenith, doeth not ſtill encreaſe, but at euery Grade of Randon are longer, till you come to the point or mount *Tropicall*, commonly called the vtmoſt Randon, which hath beene generally thought to bee the grade 45. but is not ſo. And from that *Tropicall* grade vpward, the Ranges decreaſe againe till you come to the grade Æquorizontall, ſo called becauſe the *Bullet* then falleth a like diſtance to the leuell Ranges.

THEOR. 45.

This Æquorizontall Grade is as farre diſtant from the Zenith. as that Grade is from the Horizon, which ſhall cauſe the peece to ſhoot in the Horizontall plane, a diſtance equall to his higheſt Altitude, or longeſt line Diagonall.

THEOR. 46.

The mounting of any peece aboue his Æquorizontall grade, doeth ſtill decreaſe her Horizontall Ranges, euen till it come to the Zenith. But in a proportion different from any of the former, her *Bullet* ending euery of thoſe Circuits in a direct line perpendicular.

THEOR. 47.

The Graduall encreaſe and decreaſe of theſe Ranges Horizontall, albeit they are equall in the Quadrant, yet are they neither equall nor proportionall in the Horizon, neither the Ranges nor their Interualls. Neither compared betweene themſelues, nor yet conferred with the Chords or Sines of their Arkes. And yet is there ſuch a kinde of proportionall encreaſe and decreaſe of the proportion of their Interualls, as may be reduced to a *Theoricke* certaine.

THEOR. 48.

The *Tropicall* Grade commonly called the vtmoſt Randon, is not as hath beene generally ſuppoſed the Medium, or Middle betweene the Horizon and the Zenith, *viz.* 45. but rather betweene the Horizon and the Grade Æquorizontall, which will fall out much nigher 50. from the Zenith, and 40. from the Horizon.

THEOR. 49.

The higheſt *Altitude* of any *Bullets* Circuit is fartheſt diſtant from the Peece, when ſhe is diſcharged at her vtmoſt Randon, and at all other Randons either aboue or beneath that *Tropicall Point*: That higheſt *Altitude* is euer leaſt diſtant, and the baſes of theſe Triangles doe euer encreaſe to the Randon *Tropicall*, and decreaſe after, euen as the Horizont all Ranges; but in proportion more different euery one from other.

THEOR. 50.

The *Altitudes* of the Circuits of Randons doe not encreaſe and decreaſe as their Ranges *Reciprocally*, but from the Horizon in euery Grade to the Zenith, doe ſtill encreaſe, but yet neither equally nor proportionally, neither conferred betweene themſelues, neither yet with ſines or Chordes of their Arkes of Randon. And yet the encreaſe and decreaſe of their Interualls proportions, ſuch as may bee reduced to a *Theoricke* certaine.

THEOR. 51.

The *Hypothenuſall* lines of all theſe different Circuits carry a mixt proportion of the compoſition of the proportions of theſe *Altitudes* and *Baſes* by addition of their Squares; But are not proportionall to the lines Diagonall of their correſponding Angles of Randon.

THEOR. 52.

Any two peeces of Ordinance being mounted to any one Grade of Randon, ſhall make their Horizontall Ranges of their Bullets proportionall to the *Altitudes* of their Circuits.

THEOR. 53.

The Ranges Horizontall of any two Peeces diſcharged at one Randon, will bee alway proportionall to their ſiues Diagonall of the ſame Peeces Circuits.

THEOR. 54.

The Horizontall leuell Ranges of any two Peeces of Artillery are euer proportionall to the vtmoſt Ranges Horizontall of the ſame Peeces.

THEOR. 55.

And two peeces whatſoeuer, diſcharged at one Randon, doe euer make their lines Diagonall, and lines of Altitude proportionall, howſoeuer the proportions of their charges vary.

THEOR. 56.

And two peeces whatſoeuer, diſcharged at one grade of Randon vpon any enclining or declining plane: ſhall neuertheleſſe make their Ranges proportionall to their lines Diagonall, and Altitudes of thoſe their different Ranges. Albeit the peeces bee charged with a different kinde of proportion of Powder and Bullet, ſo as the ſhot be made in a faire Calme day, as is in theſe caſes alwayes preſuppoſed, becauſe for ſuch vncertaine Accidents there cannot certaine Rules Artificiall be preſcribed.

THEOR. 57.

One Peece diſcharged, at ſeuerall Randons vnder the vtmoſt Randon, being a like charged and diſcharged, and the Peece alſo of one temper, at both times, ſhall euer make ſeuerall Ranges. But if ſhee bee diſcharged at ſeuerall Randons, the one aboue the *Tropicke* point, the other vnder: Then may their Ranges bee equall notwithſtanding their *Randons, Lines Diagonall, Altitudes, Baſes*, and *Lines Hypothenuſall*, be all different.

THEOR.

THEOR. 58.

When any Peece (being twice diſcharged at ſeuerall Randons, the one aboue, the other beneath the *Tropike* point) ſhall make the ſame or equall Ranges in a *Horizontall* plane. The middle grade betweene thoſe ſeuerall Mounts, is very nigh the grade of vtmoſt Randon: and the Peece Mounted to that middle grade, ſhall then make very nigh his vtmoſt *Horizontall* Range.

THEOR. 59.

The grade of vtmoſt Randon or point *Tropicall* of any Peece in a Plane *Horizontall*, ſhall not be the *Tropicall* grade of that Peece, in a plane declining or inclining, but an other Peculiar to that Angle of Inclination or Declination.

THEOR. 60.

Any Peece diſcharged at his grade of vtmoſt aduantage *Horizontall* vpon a Plane inclining, ſhall not make ſo great a Range as on his Plaine *Horizontall*: But contrariwiſe on a Plane diſcending ſhall make a farther Range.

THEOR. 61.

A Peece diſcharged firſt at his due leuell, and againe at his Æquorizontall grade, albeit in the plaine *Horizontall* they make equall Ranges, yet in Planes declining they ſhall not ſo doe, but alwaies the Leuell Ranges ſhall euer out-ſhoot in all declining Planes the Range of that grade Æquorizontall.

THEOR. 62.

A Peece diſcharged at any grade from the Zenith to the grade Æquorizontall, ſhall alwaies make a greater Range in any Plane enclining or declining, then on the Plane *Horizontall*.

THEOR. 63.

In all Planes enclining at all Randons betweene the *Horizontall* Leuell and point *Tropicall*, all Peeces ſhoote farther in their Planes *Horizontall*, then on any Planes enclining, and contrariwiſe in Planes declining: But aboue the *Tropike* grade not alwayes ſo, but ſometimes, and not alwayes contrary.

THEOR. 64.

In any Plane whether it be enclining or declining, if any Peece of Ordnance be diſcharged, being *Paralell* or Equidiſtant to that Plane, and the firſt graze or bound noted. If the ſame Peece be with like charge vniformely charged and diſcharged at ſuch an high grade of Randon, as may cauſe the *Bullet* Range the former Diſtance: That middle grade of the Quadrant, which lyeth betweene theſe two Mounts, ſhall be very nigh the grade of vtmoſt aduantage, for that enclining or declining plane. The which in all

planes enclining, will be aboue the vtmoſt Range *Horizontall*, and in all declinings vnder.

THEOR. 65.

In all enclining or declining planes, as the grade *Tropike* of greateſt aduantage doth varie: So doth alſo the proportions of their Ranges, at euery grade of Randon differ, whether they be accounted from the *Zenith*, or Horizon Planes, enclining or declining. But yet in ſuch an aſſured and certaine manner as may be reduced to a *Theoricke* perfect.

THEOR. 66.

In all Grades of Randons, & in all manner of Peeces, whether the planes be *Horizontall*, or vary by Inclination or Declination, the *Diagonall* Lines are ſtill proportionall to thoſe of the planes *Horizontall*, reſpectiuely taken by Graduation from the Zenith, in all Peeces whatſoeuer. But the Lines of *Altitudes*, their *Baſes* and Lines *Hipothenuſalls* are euer different in euery ſeuerall Angle, both of Inclination and Declination, and vary by ſuch a different Proportion from the *Horizontall*, as they are to be diſcouered by a ſeuerall Methode of Calculation.

THEOR. 67.

Such *Theorikes*, *Scales*, and *Inſtruments*, may be framed for the Inuention of theſe ſtrange proportions of *Altitudes*, *Lines Diagonall*, and *Ranges Horizontall*, as thereby with the aide of *Calculations Arithmeticall*, and ſome Rules *Geometricall*, a man may exactly and readily diſcouer the true Circuits and Ranges of the *Bullets* of all Peeces of Ordnance whatſoeuer, mounted howſoeuer; and vpon all grounds or planes enclining, or declining, that can be Imagined.

Definition

DEFINITION OF ARITHMETICKE.

Arithmeticke is the Art to number well, and is the ground of the Mathematicks.

Of Notation or Numeration.

The Caracters are 9 significant, as 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0, a Cypher, Remembring onely One, Ten, a Hundred, reckon all your figures or places from the right hand towards the left, alwayes making a pricke or dash ouer euery third figure, omitting the first: As suppose this number were to be valued, 4. 6 7 2. 3 5 6. So herein you find two pricks; then reckoning backe againe from the last figures on the left hand towards the right hand, name after each figure pricked so many times a thousand as there are prickes towards the right hand, saying 4 with his prick, and the next pricke is foure thousand thousand, then say fixe hundred seuenty two thousand, three hundred fifty fixe, and so of all others bee the places neuer so many, you shall name their true values to their numeration, being the common beginning is knowne well enough: This shall suffice.

The foure Principles of Arithmeticke in whole Numbers.

Addition.

TO adde is to Collect or assemble many Summes into one totall beginning at the right hand, and so proceeding towards the left: as by the example following. To adde 2356 with 5876, place them so vnder one another, that all the first figures of the summes towards the right hand stand right vnder one another: and likewise all the second figures and third, &c. of each sum directly vnder his fellow first, second, or third, &c. Thus, as 6 vnder 6, & 7 vnder 5, and 8 vnder 3, and 5 vnder the 2, and then saying 6 and 6 make 12, whereof set downe the two vnder the two fixes, and carry one for the other tenne vnto the next summe to adde to 7 and 5, saying one and seuen are eight, and fiue makes 13,

2	3 5 6
5	8 7 5
8	2 3 2.

place the 3 thereof vnder the 7 and 5, and carry one againe for the other ten to the next place, ſaying one that I carry and 8, make 9, and 3 make 12 : Of which I ſet downe the two, and for the tenne againe I likewiſe carry one vnto the next place, ſaying, one (that I carryed) and fiue make ſixe, and two make eight: which being the laſt, I ſet it right vnder the fiue, & 2. and finde that they make totally 8232.

Subſtraction.

TO Subſtract is to take a leſſer ſumme out of a greater, and to note the remainder or difference, beginning alſo at the right hand, and proceeding towards the left. As to ſubſtract 5876 from 8232 placing as before in Addition each firſt, ſecond, and third figure of the other thus

8232	
5876	
2536	

As 6 vnder 2, and 7 vnder 3, and 8 vnder 2, and 5 vnder 8. And then ſaying 6 out of 2, cannot be, but borrowing tenne from the next place maketh the 2 to bee 12, then 6 out of 12 there remaineth 6: which ſet downe vnder 6 and 2, then ſay 7 out of 3 leſſe one that was borrowed cannot be done, but 7 out of 12, that is 1 tenne borrowed out of the next place and 3 leſſe 1, that is 2 making 12 remaineth 5: which alſo ſet downe vnder 7 and 3. Then ſay 8 out of 2 cannot be, but 8 out of 11, that is, one tenne borrowed of the next, and one lent out of the 2, maketh together 3 to remaine. Laſtly, ſay 5 out of 8 leſſe one lent, that is 5 out of 7 reſteth 2. And ſo you ſhall finde that 5876, being taken from 8232 will leaue 2356, which the precedent Addition prooueth true for the remainder.

Multiplication.

TO *Multiply* ſignifieth to augment a ſumme by it ſelfe, or by ſome other number, placing the leſſer which we cõmonly name the Multiplicator vndermoſt, ſo that no figure towards the right hand outreach other, (except Cyphers) and then beginning at the right hand, and proceeding towards the left, ſtill multiplying euery figure of the vppermoſt ſumme by each figure of the lower, and ſet the products vnder the line: as the example here following will demonſtrate to the eye. And for the more eaſy ſolution of this propoſition, it will be neceſſary to know by memory the products of the multiplication of the 9 ſimple Characters, 1.2.3.4.5.6.7.8.9. amongſt themſelues. As fiue times 7. make 35, and 9 times ſixe make 54, &c. Now 4563 are giuen to be multiplyed by 327. Place the leſſer number vnder the greater with the firſt of it towards the right hand vnder the firſt of the other, & then draw a line vnder them thus, And ſay 7 times 3 make 21. Place the 1 vnder the 7 and 3, and carry 2 for the 2 tennes vnto the next place, and ſay 3 time 6 make 18, and 2 that I carryed in memory make 20: whereof I ſet downe the 0, and carry the 2 to the next, ſaying 7 times 5 make 35, and the 2 I bore in minde make 37: whereof I ſet the 7 vnder the 5 and 3, and carry 3 to the next place, ſaying 7 times 4 make 28, and 3 make 31, which I ſet downe alſo, ſo I haue done with the 7, and cancell it, and begin with the 2, ſaying 2 times 3 make 6, which I ſet downe vnder the 2, and carry

4563	
327	
31701	
9126	
13689	
1491861	

carry 1 to the next, saying 2 times 5 make 10, and 1 that I carryed make 11: whereof I set downe 1 and carry 1, and say 2 times 4 make 8 and 1 maketh it 9, which I set downe also, and so I haue done with the 2. Lastly, beginning with the 3 remaining, I say first, 3 times 3 make 9, which I set down right vnder the 3: And againe say 3 times 6 make 18, whereof I set down the 8 and carry the 1 to the next place where say 3 times 5 make 15, and 1 that I carryed make 16, whereof I set downe the 6 and carry 1 to the next, saying 3 times 4 make 12, and 1 that I carryed makes 13, and so I haue ended, onely adding the numbers vnder the line as you were shewed to do before in Addition, and you shall finde the Products will be 1491861: which hauing set downe, may be enclosed betweene 2 lines as the Operation requireth.

Diuision.

To diuide is to search how many times one some is contained in another, as if I would know how often 234 were containd in 5382, Place the greater first, and the first of the lesse towards the right hand vnder the first of the greater, thus, making a crooked line for the Quotient: and then say how often I haue 2 in 5, say two times, which 2 set behind the crooked line, or Quotient, and there will remaine 1, Then say 2 times 3 make 6, which taken from 13, there will remaine 7, which set ouer the 3. Then say 2 times 4 makes 8, which take out of the 78 aboue it, and there will rest the 70, so putting out the 8 and the 234, you must remooue the 234 one place neerer to the right hand as aboue is seene, Saying how many times two can I haue in 7, say 3 times, and yet there will remaine 1, Set the 3 in the Quotient, and the 1 ouer the 7, and put out the 2 vnderneath. And then againe say 3 times 3 make 9, which taken from 10 ouer it, there will rest 1, which I set ouer the 0, and put out the 10 and the 3 vnder it. Lastly, I say three times 4 maketh 12, which being taken out of the 12, there will remaine nothing. Wherefore you finding 23 in the Quotient, or behind the crooked line, may conclude that 234 is 23 times contained in 5382, which was desired to be knowne. If any remainder had beene, it would haue made a Numeratour to to the Diuisour, &c.

21	
270	
5382	
2344	(23
23.	

To extract the Square roote.

TO extract the true square roote (or the neerest that may be found) is to search out a nũber, that being once multiplyed in it selfe (with the remainder if any be) will produce the number assigned. As suppose it were required to finde the square roote of 4489, put vnder the 9 one pricke, and vnder the next 4 another pricke, thus leauing one figure betweene the two pricks, and so alwayes if there were more figures, and after take the square number or neerest thereunto of the number ouer the last pricke, namely of 44, which is the square 36, which taken from 44, there will remaine 8, which place aboue the pricked 4, and take the square roote of the 36, which is 6, then double the 6, and it maketh 12, which take as oft as you can out of 88, so as that the square of the second number to be produced, may also be extracted, and it will be found to be 7: which being multiplyed

8	
4489	
6	

plyed by 12, will make 84, which taken from 88, there will remaine 4, which set aboue the 8, and multiply the 7 in it selfe, and that will produce 49: which taken from the 49 ouer it there will rest nothing, and so you shall finde 67 to be the square roote of 4489; for multiply 67 it in selfe, it will produce 4489.

To extract the Cubicke roote.

To extract the Cubicke roote of any number is to finde that number, that being multiplyed in it selfe, and the product againe by the same number, will make the number assigned (or the neerest thereto if the number be not a Cubicke number.) So to extract the Cubicke number of 32768, place one pricke vnder the first figure 8, and another vnder the fourth figure 2, and so further if there be more to leaue two figures between each two prickes, and looke (as before for the square roote) how many pricks there be so made, so many figures there will be in the Quotient, and then seeke the Cubicke root (or the neerest to it) vnto 32, which will be found to be 3, which multiplyed in it selfe maketh 9, and that product againe multiplied by 3, produceth 27 out of 32, substracting 27, there will remaine 5, and that may be set ouer the 2, and the Quotient 3 also by it selfe. And then to find the 2 figure of the Quotient, put down 3 and his square 9, & his Cube 27. Now we must take a new number in the Quotient, so that when the 27 shalbe multiplied by the same number, which is 2 and the 9 by the square of 2 which is 4. and againe the new number cubickely in it selfe, and placing the 3 products in order, as the operation here set downe sheweth, and the same Agregate substracted from the remainder of the diuision, that in this extraction there shal want nothing, so the Quotient will be found to be 32, which multiplyed cubickely will make his Cube 32768.

32768
3 2

By the square roote all sorts of Battalions are framed thus. *viz.*

To make a square Battallion of Men.

EXtract the square root of the number of men proposed, and it will yeeld the number both for Ranke and also for Fyle.

To make a Battallion square of ground.

Allow 3 foote in breadth, and 7 in length, which is the space that euery Souldier occupyeth marching, Multiply the number of men proposed by 3, and diuiding the products by 7, then extract the *Square root* of the Quotient, and that will be the number of men for the Fyles. By which then diuiding the said number proposed, and the Quotient will be the number of men in Ranke.

To make a Battallion whereof the Front shall be to the Flancke in any proportion giuen.

Multiply the number of men proposed by the proportion appointed for the Flancke, and from the product extract the Square roote, which will bee the number of men for the Fyles or Flancke. And againe to finde the number

ber of men for the Front, Multiply the propoſed number of men by the proportion aſſigned for the Front, and from the product thereof, extract the Square roote, which roote will be the number of men for Front.

To make a doubled Batallion.

Double the number of men propounded, and extract the ſquare roote of that, and it will be the number of men in Front: Then halfe that number, and it will be the number of men for Flancke.

To make a Batallion of a great Front.

Diuide the number of men propounded by the number of men aſſigned for the Front, and the Quotient will be the number of men for the Flancke.

The *Batallions* ſquare of men, or ſquare of ground, are weake in Front, and thoſe of great Front, are weake in Flancke.

The *Spanyards* moſt commonly vſe the doubled *Batallia*.

And the *Hollanders* the great Front, for they vſually make their Flancke conſiſt but of tenne Rankes.

By the extraction of this Cubicke roote you may find the ſolid capacity of any Shot, Ordnance and ſuch like ſolides: hereof we will ſpeake more hereafter in his place.

A Table ſhewing the Square roote vnto 3844, *and the Cubicke roote vnto* 238328. *Calculated by the Author* R. Norton.

	1	
4	2	8
9	3	27
16	4	64
25	5	125
36	6	216
49	7	343
64	8	512
81	9	729
100	10	1000
121	11	1331
144	12	1728
169	13	2197
196	14	2744
225	15	3375
256	16	4096
289	17	51 3
324	18	58,2
361	19	6859
400	20	8000
441	21	9261
484	22	10648
529	23	11197
576	24	13824
625	25	15625
676	26	17576
729	27	19683
784	28	21952
841	29	24389
900	30	27000
961	31	29791
1024	32	32768
1084	33	35772
1156	34	39204
1225	35	42875
1296	36	46656
1369	37	50653
1444	38	548 2
1521	39	59319
1600	40	64000
1681	41	68921
1764	42	74088
1849	43	81307
1936	44	85184
2025	45	87120
2116	46	97336
2209	47	103823
2304	48	110592
2401	49	117649
2500	50	125000
2601	51	132651
2704	52	140608
2809	53	148877
2916	54	156464
3025	55	166375
3136	56	175616
3249	57	185193
3364	58	195092
3481	59	208179
3600	60	216000
3721	61	226981
3844	62	238328

To finde the Fractions Quantity, when the number giuen is not a square number.

VVHen you haue extracted the Square roote of any number, and that yet there resteth something after the extraction made, that sheweth the number not to be a Square number, and being very difficult to finde the roote of a number, not square, exactly, but to come neere it: double the roote for denominicator, and take the remainder for numerator. *Example*, I would find the square roote of 10, the greatest Roote in 10 is 3, and 3 times 3 maketh 9, so the remainder is 1 for Numerator, and I double 6 for denominator, so the neereſt square roote of 10 is $3\frac{1}{6}$ which is $\frac{1}{36}$ part too little. But if I should adde 1 to the double of the Roote for denominator, and take the remainder for Numerator, that would make the roote of 10 to be $3\frac{1}{7}$, which is too much by $\frac{1}{42}$ part.

Of Fractions.

What a Fraction is, and to reduce Fractions.

A Fraction is a part of a whole number, and the proportion thereof is to the whole number as the Numerator is to the Denominator of the same. And where the Numerators and Denominators are great numbers, they are to be reduced into their least denomination: which to doe, is to finde the greatest number that will diuide them both. As I would abreuiate $\frac{225}{300}$, I finde 5 the number that is common to diuide them both, and thereby I first diuide 225, and thereof commeth 45 for numerator, then I diuide 30 by 5, and that produceth 60. I say then $\frac{45}{60}$ valueth as much as $\frac{225}{300}$. But to finde the smalleſt fraction, take 225 out of 300, and there will reſt 75, and then I take 75 out of 225, and there reſt 150: then I take 75 out of 150, and there reſt 75, which is the number I seeke, whereby I first diuide 225, and the Quotient will be 3, then I diuide 300 by 75, and the quotient will be 4, so $\frac{1}{4}$ and $\frac{45}{60}$ and $\frac{225}{300}$, are of one and the same value equall amongst themselues, and one to another. And so you may doe with any other fraction to reduce it to the last denomination.

Againe, some fractions cannot be abreuiated, as $\frac{11}{12}$, out of such a fraction take 2 or 3 vnities from the Numerator, that is, take $\frac{2}{12}$ from $\frac{11}{12}$, and there will reſt $\frac{9}{12}$, and reduce the $\frac{9}{12}$ to $\frac{3}{4}$, so $\frac{3}{12}$, and $\frac{1}{4}$ is equall in value $\frac{3}{12}$.

To reduce many diuers Fractions into one denomination, There can but two of them bee reduced at once; as I would reduce $\frac{3}{8}$ and $\frac{4}{6}$ into one denomination I set them thus, $\frac{3}{6}\,\frac{4}{8}$: And multiply the two denominators together, and they make 48, which shall be the denominator, then I multiply 6, the first denominator by 4 the second numerator, and thereof commeth 24 which I set apart for the first, then I multiply 8, the second denominatour by 5, the first Numerator which produceth 40, which I also set apart for the second Numerator, each set ouer the denominator 48, will be

be so reduced to $\frac{44}{48}$ and $\frac{42}{48}$ or $\frac{42}{48}$ or 1 and $\frac{44}{48}$ equall to $\frac{1}{4}$ and $\frac{1}{6}$.

Addition of Fractions.

But if all the Denominators be a like, adde all the Denominators together, and set their common Denominator vnder the sums of them, as $\frac{1}{6}\frac{2}{6}\frac{3}{6}$ make $\frac{12}{6}$, or 1 $\frac{6}{6}$.

Substraction of Fractions.

To substract one Fraction from an other, first (if they be not) reduce them to one Denomination, as to take $\frac{2}{3}$ from $\frac{3}{4}$ which reduced, make $\frac{8}{12}$, for $\frac{2}{3}$ and $\frac{9}{12}$ for $\frac{3}{4}$, then substract $\frac{8}{12}$ from $\frac{9}{12}$ rests $\frac{1}{12}$ the remainder sought.

Multiplication of Fractions.

To Multiply Fractions, you must Multiply the Numerators together for a new Numerator, and also the 2 Denominators together for a new Denominator, as $\frac{2}{6}$ by $\frac{4}{7}$ produce $\frac{8}{48}$ or $\frac{4}{24}$ or $\frac{2}{12}$ or $\frac{1}{6}$.

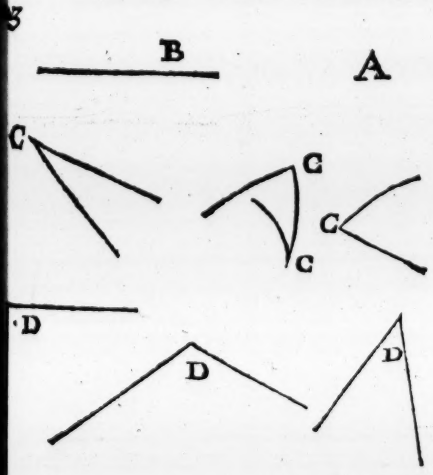
Diuision of Fractions.

To diuide Fractions one by an other the easiest way, is to make one of the Denominators to stand as Numerator, and the Numerator thereof as Denominator, and then to worke as you did in Multiplication of Fractions: As I would Diuide $\frac{3}{4}$ by $\frac{2}{3}$ I changing one, they stand thus $\frac{3}{4}$ and $\frac{3}{2}$ and say 3 times 3 make 9, and that 4 is Numerator for the Quotient, and 4 times two makes 8 for Denominator thereof: So $\frac{3}{4}$ Diuided by $\frac{2}{3}$ make $\frac{9}{8}$ the Quotient sought.

Definitions.

Geometry *is the Art to measure well, and is the Sinewes of the Art of* Artillerie.

Geometry hath her Originall from *Poynts, rights, crooked lines, right* and *oblique Angles, Superficies,* and *Bodies,* &c.



A *Poynt* is a thing that cannot be diuided as *A*.

A Line is a thing that hath *Length* without *breadth*, & scrueth for lengths, breadths, heights, and depthes, as *B*.

An *Angle* is the meeting of two lines, so as they make not one *line*, and are either right lined Sphæricall, or mixt Angles, as *C*.

And an *Angle* is a right angle, a blunt, or a sharpe *Angle*.

An angle greater then a right *angle*, is a blunt or abtuse *angle*, as *D*.

An angle lesser then a right angle, is a sharpe or acute *angle*, as *E*.

A superficies is that which hath on-

ly *Length* and *Breadth*, as a Quadrate or Triangle, &c. as E. E.

A *Body* is that which hath *length* and *breadth*, and also *thickneſſe* as a Cube, &c. *F*.

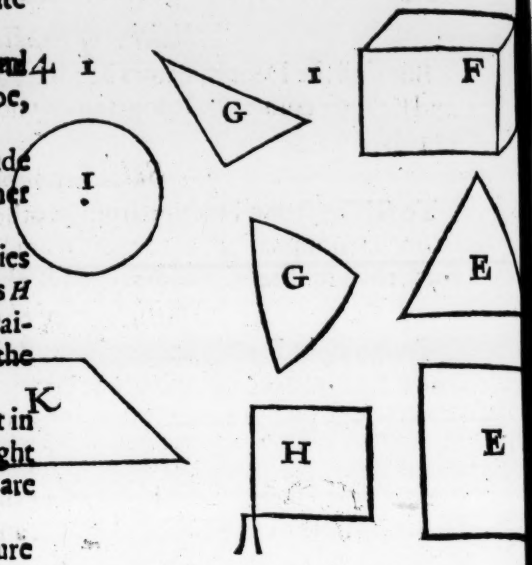
A Tryangle is a ſuperficies, made onely with three lines, and is either right lined, or Sphæricall, as *G*.

A *Quadrat* or *ſquare* is a ſuperficies quadranguled, made of foure lines, as *H*

A Circle is a plane Figure, contained vnder one line, which is called the *circumference* thereof. as I

A Centre of a Circle is a point in the midſt thereof, from which all right lines drawne to the circumference, are equall, as *I*. alſo

A Trapezia, is a right lyned figure of foure vnequall ſides, as *K*.



The eſpeciall things belonging to a Gunner, being *Arithmetick* (which we haue heercin briefely touched) and *Geometry* which wee now purpoſe to point at, and *Perſpectiue* whereof hereafter a word for taking diſtances: And of each of them in as briefe manner as I can, becauſe they are not by neceſſity to be accounted any reall parts of this Art and Practiſe of Artillery, but only neceſſary apendants thereto: For it is neceſſary that the Gunner ſhould know what a line, a ſuperficies, and a body is, and how to meaſure each of them; as well the right as the crooked, the leuell Hypothenuſall & perpendicular & diametral lines, and the Angles they can make right or obliques. And meaſure the Triangles, Squares, and Circles, the Globes, Columnes, and Cillinders: And in effect to carrie in his memory theſe *Definitions*, *Demands*, and *Common ſentences*, of *Euclids Elements*: and eſpecially the firſt *Propoſition* of the ſame which teacheth.

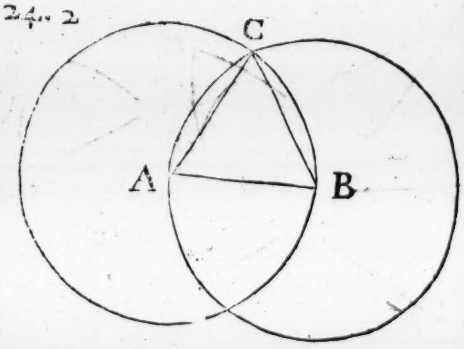
How to make an *Equilaterall Triangle*.

EVCLID. I. PROPO. I.

Which is, *Vpon the giuen right line* Ab, *to make the* Equilaterall Triangle abc.

With the diſtance *a b*, vpon *a* and *b* deſcribe two circles, the interſection *C* * ioyned with *a* and *b*, ſhall make the Equilater tryangle *a b c* required.

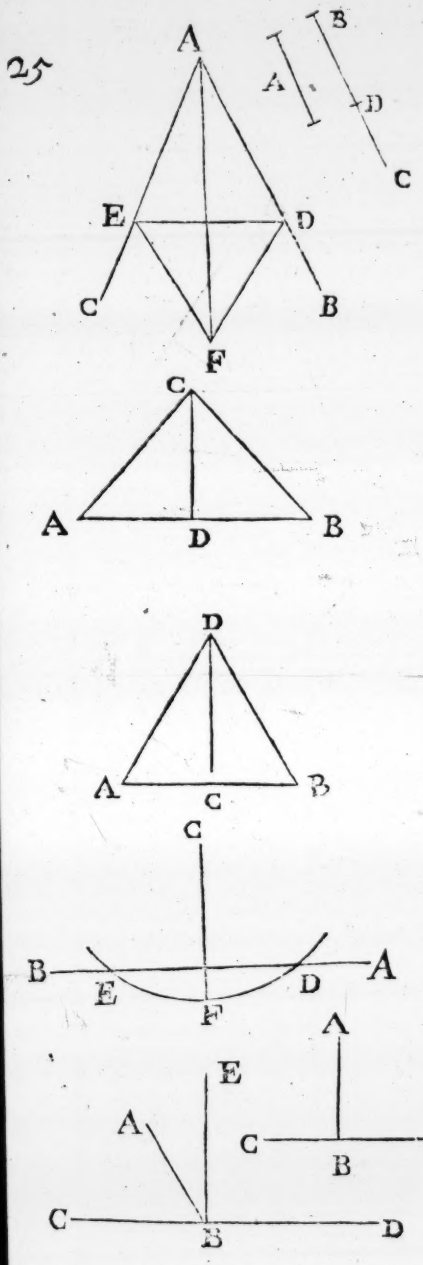
* 1. *Dem.* 1.



And then the 3. PRO. I.

Two vnequall right lines being giuen, to cut from the greater a right line equall to the leſſer.

From the Centre *B*, with the diſtance



A * cut *C B* in *D*, ſo will *B D* bee e- * 2. 1.
quall to *A*. 15. *Def.* 1.

And the 9. PROPO. 1.

To diuide an angle giuen by a right line in the midſt, or into two equall parts.

To halfe the giuen Angle *b a c*, with a right line.

From *a b* * cut *a d* at pleaſure, and * 3. 1.
alſo *a e* equall thereunto, and draw the * 1. 1.
right line *D C*, and make the *Equilater triangle D E F*, and ioyne *A F*, which will halfe the giuen angle.

And the 10. PROPO. 1.

To halfe a giuen right line as A. B.

Vpon the right line *A B*, make the Tryangle *A C B*, the angle *C* * halfed. * 1. 1.
* 9. 1.

And the 11. PROPO. 1.

To raiſe a prependicular line C F *vpon a right line* E D *from a point* C *therein giuen.*

Vpon the point *C* ſet the Compaſſes, and on each ſide thereof in the line *E D* take equall diſtances at pleaſure, and vpon them make * an equilater Try- * 1. 1.
angle *D E F*, and then draw the line *F C* which ſhall bee perpendicular to *E D* vpon the point *C*.

And the 12. PROPO. 1.

Vpon an infinite right line a b *giuen, from a point* C *without the ſame, to let fall a perpendicular right line* C F.

Vpon the Centre *C* the Arch of a circle deſcribed, will cut the right line *A B* in *D* and *E*, diuide *D E* into * halfe * 10. 1.
at *F*, ioyne *C* to *F*, and ſo *C F* will bee perpendicularly let fall at *F* vpon *A B*.

And the 13. PROPO. 1.

A right line a b *falling vpon another right line* c d, *maketh either two right angles, or elſe angles equall to two right angles.*

In the perpendicularity of *E B* to *C D*, it is ſufficiently manifeſt; but if *A B* be not perpendicular in the poynt *B* * erect the perpendicular *E B*: ſo we * 11. 1.
ſee the angle *A B C* and the angle *A B D* taken together, to occupie the place of

the two right angles *E B C* and *E B D*.

And the 21. PROPO. 1.

If within a Triangle a b c *in the side* b c, *from the extreames of two right lines* b d *and* c d, *they are lesse then the sides* A B *and* A C, *but the angle* D *that subtends it, will be greater then the angle* A.

Continue out the side *B D* to *E* in the tryangle *B A E*, the sides *B A*, *A E* taken together, are greater then * the third *B E*, and *D* is therefore greater then * *A*.

*4 Axio. 1

*16. 1.

And the 31. PROPO. 1.

By a point giuen A *to the giuen right line* B E *to draw a right line paralell.*

Draw *A D* * that it make the alterne angle *A D C* equall to *D A F*, and continue *F A* to *E*, and the Alternates being equalls, the lines must be paralell.

*23. 1.

*29. 1.

And the 32. PROPO. 1.

Euery Triangle as A C B *with one side produced* A B *to* D, *The externall angle* C B D, *will be equall to the 2 internall opposite Angles* A *and* E, *the three angles of a Tryangle being equall to two right angles.*

To the side *A C* * make the paralell line by the point *B* namely *B E* in these two paralells *A C* and *B E*, the line of incidence *C B* maketh * *C B E* equall to *E B D*, and *B* equall to *A*: so the whole externe angle is equall to the two interne angles, to which let the third *C B A* the common angle, and the three angles of the Triangle equall to two right angles.

*31. 1.

*29. 1.

*13. 1.

And the 46. PROPO. 1.

Vpon a right line A B *giuen to make the square of equall sides, and equall angles* A B C D.

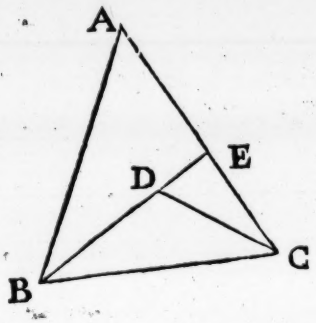
From either extreame as *A* of the giuen line, let the perpendicular line *A D* be * erected equall to the giuen line, and by *D* make to *A B* * paralell and equall the line *D C*, ioyne *C* and *B* equall, and paralell *A B C D* ioyning *D A* and *C B*, they will be equall. And the Parelellogram made * equilaterall, and

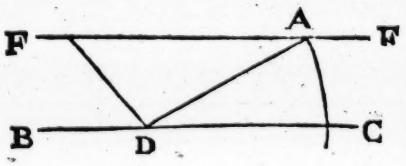
*11. 1.

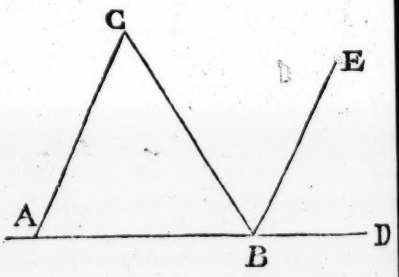
*31. 1.

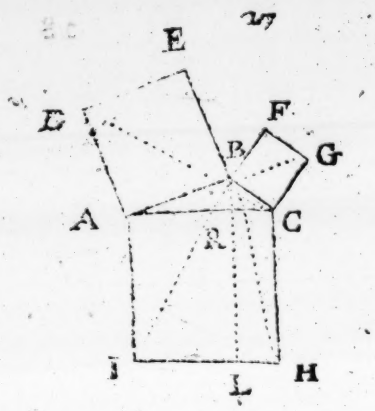
1 Axiom. 1.

26









and becauſe the Angles *C* and *B* opoſite to the right angles *A* and *D*, it is a rectangle and *.* a ſquare. *.*30.1.

And the 47. PROPO. 1.

In the rectangled Triangle A B C, *the ſquare that is made of the ſide* A C, *ſubtended by the right angle* A B C *being deſcribed, will bee equall to the Squares* A B E D *and* B C G F, *which are deſcribed of the ſides containing the rectangle.*

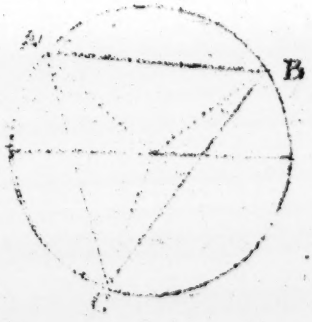
Let the three Squares *A H*, *A E*, and *C F* be deſcribed, and in a direct line let *A B*, *B F*, and *C B*, *B F* lye, and draw *B L* paralell to *A I*, and draw alſo *B H* *B I*, *A G*, and *C D*.

The common angle *A B C* being added to the rectangles *D A B* and *I A C*, are* equall to the Angles *I A B* and *2 *Axiom.* *D A C*, *and alſo to the tryangles. *4.1.

And the 5 PROPO. 4.

About a Tryangle *to deſcribe a circle.*

Diuide any two of the ſides into the *midſt by perpendicular lines meeting in *F*, from whence draw a right line to each angle, and by their diſtance deſcribe the circle. *F A*, *F B*, and *F C*, will be* equall, and vpon the *centre *B* a circle is deſcribed about the tryangle. *10.1. *4.1. *9.3.



1. *If the centre fall in the ſide the tryangle is rectangled, if within Acute, if without obtuſe angled. *31.3.

2. By three points not being in a right line to deſcribe a circle by this proportion, for ioyne the 3 poynts and you haue a Tryangle.

And the Corolaries and the *Scholion* thereof, *viz.*

To euery regular figure that is equilaterall and equiangled, a circle maybe as well *inſcribed by the diſtance of the perpendicular, as ſubſcribed with the diſtance to the Angles, and thoſe cut in halfes. *4. *6.1.

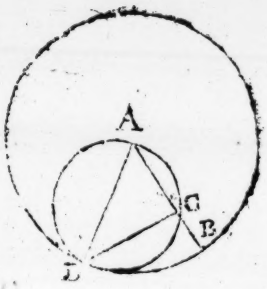
And the 10 PROPO. 4.

To make an Iſoſceles Triangle that may haue either of the angles at the Baſe double to the reſt.

Any *giuen line as *A B*, that the rectangle *11.21.

rectangle vnder *A B* and *C B*, may bee equall to the ſquare of *A C*, and by the diſtance of *A B* if a circle be deſcribed,
*11. 2 it will * make *B D* equall to *A C*, then ioyne *C D* and *A D*, and the Tryangle
*1. 4 *A C D* may bee * circumſcribed by a
5. 4 circle.

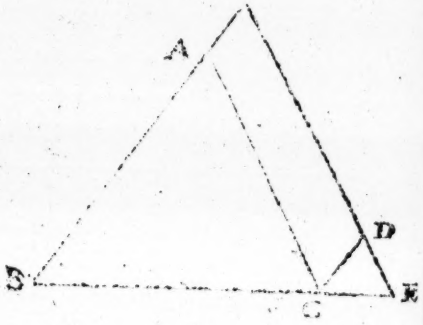
Therefore becauſe the ſquare of *A B* is equall to the rectangle, by the cutting of *B A*, and the outward ſegment *C B* it will be tangent, and the angle *A* to the angle *C B D* will be equall, and adde the common angle *A D C*, and *A D B* will then be equall to the angle *A* and *C D A*, that is to the angle *B C D* or *B*: And ſo the ſides *B D*, and *C D*, and *C A* will bee equall, and likewiſe the angle *A* to the angle *A D C*; and ſo the angle *A* $\frac{1}{3}$ doubled *B C D*, or double at the Baſe *B* $\frac{2}{3}$ and *D* $\frac{1}{3}$ in the *Iſoſcelles* tryangle *B A D* deſcribed.



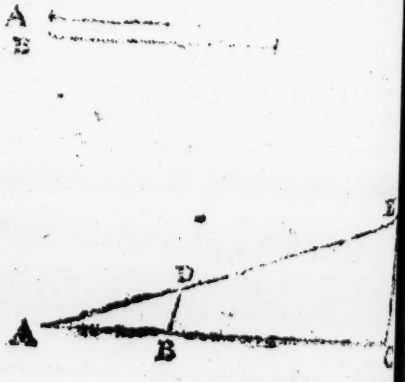
28

And the 4 PROPO. 6.

Of the equiangles A B C, D E F *of the Triangles the ſides are proportionalls, as* A B *to* B C, *ſo is* C D *to* D E, *and as* B C *to* C A, *ſo* C E *to* E D, *and as* B A *to* A C, *ſo is* C D *to* D E, *which about equall angles* B *and* D E, E B C A *and* E, A *and* D *are Homogeneall ſides* A B *to* D C, B C *to* C E, *and* A C *to* D E, *which ſubtend* B C A, *and* B A, *and* C D, B *and* D C E



Let the Baſes of the Tryangles be B C and C E, & according to the quantity
*11. 1 of the angles like ſcituate in one direct line, and B A and E P meete extended in F: Therefore becauſe the angles A C B and E, and D C B and B, are equall, B F and C B will be paralells, and
*28. 6, alſo A C, and E F, and A C D F * a parallelogram.

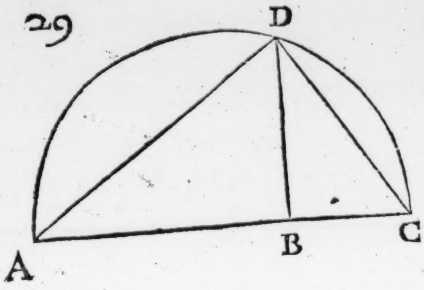


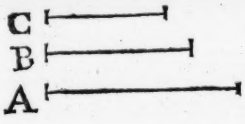
And the 12 PROPO. 6.

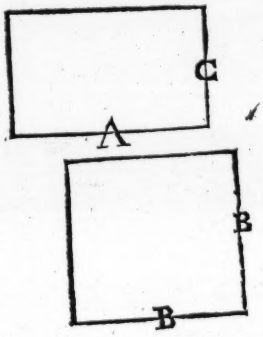
Three lines being giuen to finde a fourth proportionall.

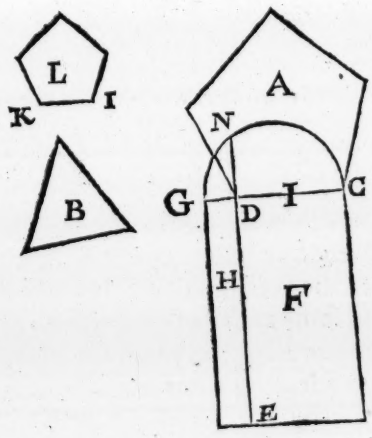
Of the lines giuen let A B the firſt and B C the ſecond bee ſet in a direct line, and at any angle draw a third right line infinitely extended, wherein

let









set A D, the third giuen line draw together DB, and by C draw the * Parellell thereunto CE, so it will be as * AB the first, to BC the second, so will AD the third be to CE the fourth sought. * 31. 1. * 2. 6.

And the 13 PROPO. 6.

Two right lines AB, BC, *being giuen to finde a meane proportionall betweene them.*

Set the two right lines giuen in one direct line as AB, BC, vpon all that line A C, describe the semicircle ADC, and from B * raise the perpendicular line BD, and draw AD, CD: therefore A D C is a right angle (being in a semicircle) and BD the perpendicular maketh two triangles ABD and CBD * equiangled, and therefore proportionall: Therefore BD is the meane proportionall. * 11. 1. * 8. 6.

And the 17 PROPO. 6.

If three right lines be proportionall, as A *to* B, *so* B *to* C, *then that rectangle that is made of the extreames* A *and* C, *shall be equall to that which is made of the Meane* B.

Becauſe the meane proportionall B is twice put, it will bee as in the 16. *Pro.* that 4 right lines about 4 right equall angles, are * reciprocally proportionalls, Therefore rectangled * and equall: and contrariwise being equally rectangled about right angles, they haue their sides reciprocally proportionals, *viz.* as A to B, so is the same B to D, which was to be shewed. * 1. *Def.* 6. † 14. 6.

And the 25 PROPO. 6.

Any right lyned figure giuen a like, and in like sort placed, to make another equall to the giuen.

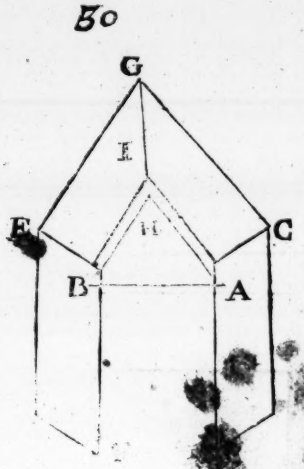
Let A be the right lined figure giuen, a like vnto which is to bee made. To the side D C at angle C D E, let the * paralellogram F equall to it bee applied: Againe to the side of this D E there may be applyed contiguat to E D G, the Paralellogram H equall to a right lyned figure B, vnto which it is to bee * 44. 45. 1.

constructed equally between CD and
*13.5 DG *seeke the meane proportionall DN or IK: vpon which the right lined figure *A* is to bee made equall to B. Wherefore seeing it is as the first CD, is to the third DG, so is F to H, that is *A* to B, and *A* to L, and also L is equall to * B made like to *A* which
*22.5 was to be done.

And lastly the 14. PROPO. 11.

To what planes soeuer ED *and* EF *the same right line figure* AB *is right, they are paralells,*

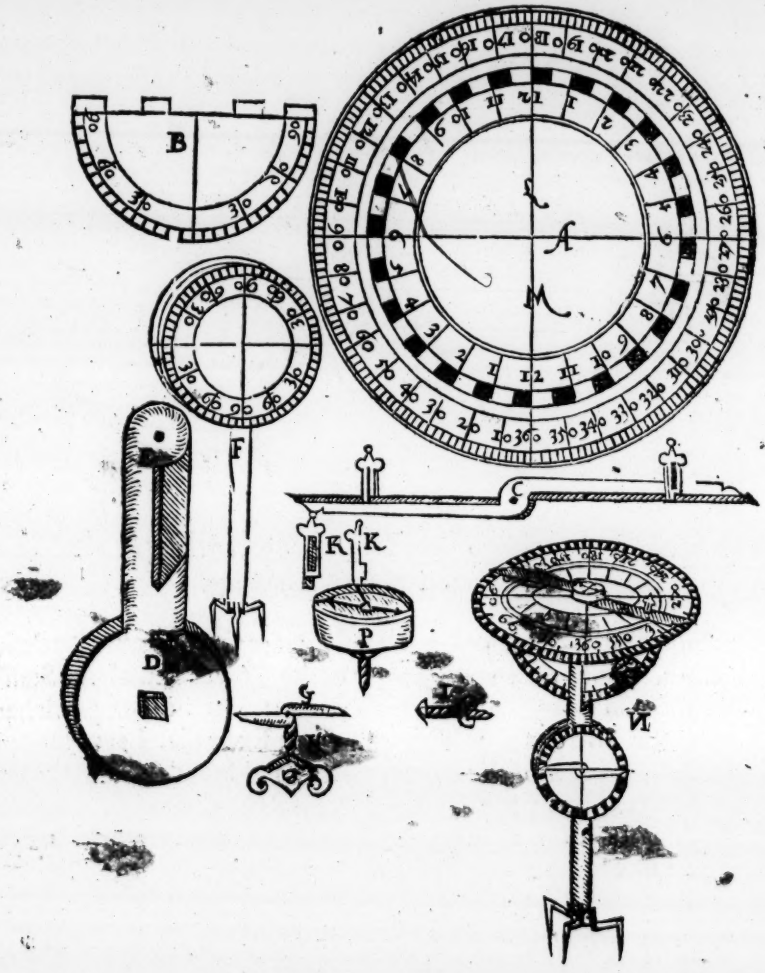
If they be not Paralells being produced, they will concurre to the parts
*3.11. C,E, and * make the Section GH a right line, in which any where take the point I, and draw I A, I B in the planes G C D and G E F. And so when as A B is placed right to either, it will bee the plane of the Triangle A I B, the angles L A B and I A B would be right, which
17.1. are neuertheless * lesser then right angles.



To measure inaccessible Heights, Breadths and Distances, and take a plat by my Cosmodelite with the description thereof.

VPon the semicircle vnder the Cosmodelyte there are two squares Geometricall, each side of them being diuided into 120 equall parts, and vpon the Centre of that Semicircle a Rule or Index with the two sights ouer or parallell vnto the fiduciall edge thereof. As suppose I were to measure the distance from me to a Tree, to doe which, place the Semicircle, so that the Index layd vpon the Dyametrall line may direct with the sight to the tree or marke, then laying the Index vpon the Semidiametre that is perpendicular to the Dyametrall line, and choose some marke of competent distance whereunto the sights direct, or els measure 20 or 100 yards, paces, or feet in that line, and there set a marke, and then leauing a marke where you first stood, remone your instrument thither, and by the Semidiametrall line looking backe to the first station or marke, thereby you may place the Semicircle in the first position; which done, turne the Index vnto the Tree or Marke, whose distance you are to measure, and see what number of those 120 parts it cutteth, then, say by the Rule of 3, If 120 all the parts, the parts cut, as suppose it were 80. What shall 300 yards which I imagine was measured betweene the first and second Stations giue, multiplying the third

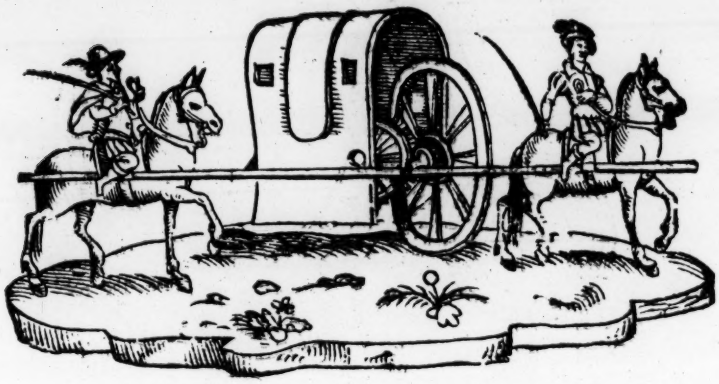
third number 300 by 80, the second number produceth 8000, which diuiding by 120, the first number yeeldeth 66 yards ⅔ the distance so right.



To measure the breadth of a Breach.

LAy on the Index vpon the Dyametral line, and turne that to one side of the Breach, and the instrument remaining in that position, note the number the Index will cut when it is turned with his sights to respect the other side of the Breach, then goe forwards or backwards vntill you see the last side of the breach by some other number of parts (letting a conuenient distance betweene the Stations) and noting the difference of those parts, and the distance of the Stations measured, suppose, 50 yards and the difference of parts to 20. Say by the rule of three, if 120, all the parts giue 20, the parts cut by aspect of the Index, what shall 50 yards giue, multiplying 70 by 50

produceth 3500 : which diuiding by 120, yeeldeth 29 yards, and $\frac{2}{3}$ patts of a yard, the breadth of the Breach ſought. A height is taken in the ſame manner, onely reuerſing the Plane of the Inſtrument perpendicular, which before did lye Horizontally, imitating the reſt of the worke as aforeſaid.



To meaſure the height of any Tower, or other thing by the ſhadow it maketh, the Sun ſhining.

TAke a ſtaffe and place it perpendicularly neere the ſhadow you deſire to meaſure, marke the two ſhadowes of the Tower and of the Staffe, then ſuch as the ſhadow of the Staffe hath proportiõ to the ſtaffe, ſuch hath the ſhadow of the Tower to the Towers height. Example. Let vs ſuppoſe the length of the ſhadow of the ſtaffe to be 12 hand-breadths, and the ſhadow of the Tower to be 45 foote; the ſtaffe was 8 hand breadths. Then ſay by the Rule of proportion: if 12 giue 8, what ſhall 45 giue : worke and yee ſhall haue 30 foote for the height of the Tower ſought.

To meaſure the height of a Tower by a looking-glaſſe, or the ſhadow thereof in a puddle of water.

SVppoſe there is a Tree or Tower whoſe height we deſire to know: Take a flat Mirror, or Looking-glaſſe, and lay it leuell or Horizontally vpon the ground ſome diſtance from the Tree or Tower, and then goe backewards vntill in beholding in the Glaſſe you thereby ſee the top of the Tree or Tower, your diſtance from the glaſſe hath proportion to the height of your eye, ſuch as the diſtance from the glaſſe vnto the poynt right vnder the top of the Tree or Tower, is to the height of the ſaid Tree or Tower, As for example, ſuppoſe the diſtance betweene the Glaſſe and the Tower were 48 foote, and the diſtance betweene you and the Glaſſe be 4 foote, and the height of your eye abone the leuell of the glaſſe to be 6 foote, ſay, if 4 giue 6, what will 48 giue, multiplying 48 by 6, produceth 288: which diuide by 4 giueat in the Quotient 72 for the height of the Tree, or Tower ſought.

To

To finde any distance, height, or breadth by resoluing the Triangle made by Stations and Markes.

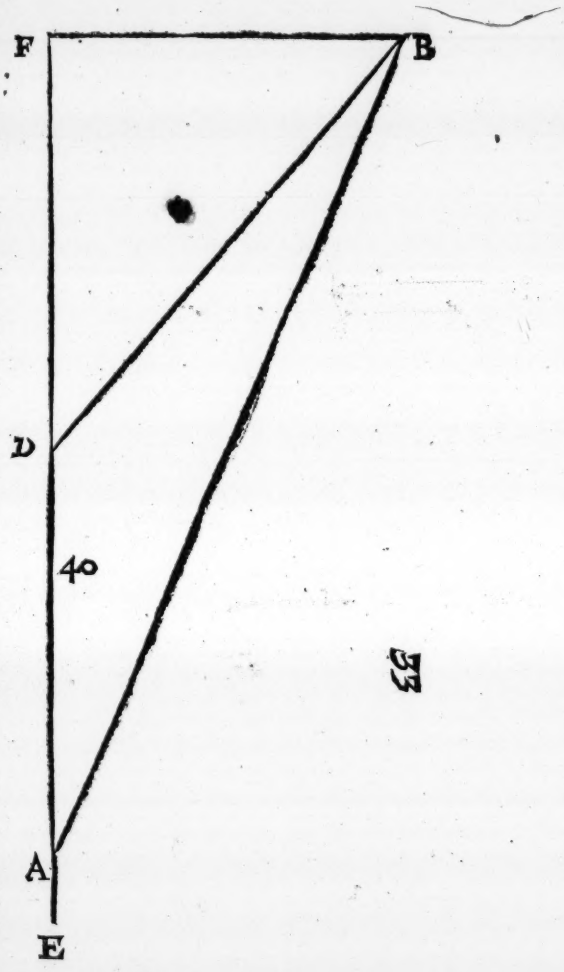
TO finde the vnknowne sides and angles, any 3 of these sides and angles being giuen, so one bee a syde, to finde the rest by Addition and Substraction. By the Table of Logarithmes remembring this Theoreme, That the Sydes in all plane Triangles are in proportion one to another, as the Synes of the Angles they subtend. *Example.*

Suppose that *B*, *C*, in the Triangle, *A*, *B*, *C*, be the height of a Tower, and let it be required to finde the measure thereof, and of the Hypothenusall lyne *A B*, First measure the distance frō *A* to *C* supposed 40 paces, then by the Cosmodelite or other instrument planted at *A*, take the quantity of the angle *B A C*, 30 degrees, then by consequent the angle *A B C* will be the complement therof 60 degrees (the angle at *C* being a right angle) and all the sides of a right line triangle being equall to two right angles, so there is already had 4 of the 6; namely, the 3 angles and the syde *A C*. Then finding the Logarithmes of the Angles. As for the Angle sixtie degrees, and for the angle 30 degrees, and for the rectangle *C* 90 degrees. Then say by the Rule of proportion, if *A C* the syne of the Angle *A B C* giue *B C* the syne of the angle *B A C*, what giues *AC* 40 paces, and the Logarithme of *A C* to the Log of *B C*, and thence substract the Logarithme of *A B C*, and the Log: of the syne remaining willbe $23\frac{2}{4}\frac{7}{3}$ for *B C* sought.

And for *A B*, the Hypothenuse say, if *A C* gine *A B*, what will *A C* 40 paces giue *facit*, $46\frac{1}{3}$ *fere*.

The like may be done for all distances and breadths whatsoeuer.

Thus much shall suffice for the apendants. Now to the principall matter it selfe.



The Deſcription of the Horſe-litter, and the Coſmodelite, and to Delineate by eyther of them any Champion aſsigned.

THis Inſtrument, the *Coſmodelite* is ſo plainly demonſtrated to the Eye by the Figure thereof, that it needeth few words for further deſcription; Only, you may perceiue it to haue ſo many ſeuerall bendings, that it may at once repreſent any two or three planes aſsigned: It conſiſting of two concentrick Circles diuided, one into 360 equall parts as at *A*: The other into 24. and a ſemicircle, each Quadrant diuided into 90 equall degrees as *B*: and within each Quadrant is a Geometricall Square, each ſide thereof diuided into 120 parts; It hath an Indez with ſightes, as *C* playing vpon a Centerpinne, vnder a boxe with a Magneticall Needle therein as *P*: Vpon the bottom of the Boxe is paſted a Chart of the 32 Poynts, and a Limbe of 360 degrees: It hath alſo a Circle with Ioynts at the knee, with an Index as *F*, to inclyne or reclyne the Inſtrument to any Angle aſsigned, the Cheekes, the ſquare hole of the halfe ſlitts between *D* and *E* being the Index & mouing of the ſupporters of the ſaid Semicircle, & circles, *B* and *A*, as it, and altogether conſidered, are repreſented at *N* to the eye very apparantly.

It is an excellent and generall Inſtrument, if it be well made, vnderſtood, and vſed as it ought to be: This ſhall ſuffice, with the former Figure in the 31 for the Deſcription, and ſome vſes thereof; Only a word or two, how to deſcribe a Champion in plaine by it, and a whole Region by the Horſe-litter, whoſe Figure is alſo in the 32 Page hereof ſhewed.

To make and Deliniate in Platte any Champion, or Region aſsigned.

THe Horſe-litter trauelling of purpoſe, with the motion of the Wheele hanged in ſteele Springs, roaling on the way, The other Wheeles which it turneth, giueth the Meaſures of Paces, Yeards, or Feete, conteyned between euery two angles, and the Compaſſe within, deliuereth to the Obſeruor (ſitting within the Litter) the alteration of angles from time to time, which he diligently noting in a Booke, with all obſeruable things, as Townes, Villages, Hills, Woods, Riuers, Valleys, Parkes, Waſtes, and Incloſures in his way notable, to protract by the degrees of the Needle, or poynts cut, and meaſures found betweene angle and angle, with the obſeruable Circumſtances not forgotten; And by the *Coſmodelites* Index and Needle noting the degree cut, it reſpecting each obſeruable Marke, at the firſt, ſecond, third ſtation, &c. If need be of ſo many noted, and the diſtance of each ſtation from other being meaſured with a Chayne, Lyne, or two Poles, or ſuch like, in knowne Meaſures alſo protracted, the true Platte of a whole Region, Mannor, Champion or Field, may be eaſily Deſcribed, by practizing duly what hath been already ſaid, & all Diſtances, Heights, Breadths, & Profundities acceſsible or inacceſsible alſo meaſured: As Maſter *Diggs* in his *Pantometria*, and Maſter *Rathorne* in his third Booke of the *Surueyor* haue largely (with variety) deſcribed, which with great eaſe, the diligent Practician may well apply to eyther of theſe Inſtruments, which let ſuffice.

THE

THE PRACTISE OF ARTILLERIE.

CHAP. I.

Of the generall definition and distinguishing of Ordnance and Artillerie.

ARtillery generally taken, comprehendeth all manner of artificiall Engines for the Wars, diuised or vsed at any time, eyther to hurle Stones or Darts, or to shoote Arrowes or Bullets, or such like things, to, or at any remote Obiect; and that with greater violence and more certain direction, then by the naturall strength of any one mans hand can possibly bee otherwise performed: Whereby it appeareth also, that *Artillerie* differeth from all other Engins. First, for that all other Engins exercise their violence eyther vpon Obiects at hand, or such as are eyther neere ioyned vnto themselues, without whose presence or contingencie they effect nothing at all: whereas *Artillerie* exerciseth her force and violence vpon things farre off, euen when the Obiect is not present or neere it. Secondly, in the exercise of other engins, the speciall thing required is strength and labour, rather then any great Art or Skill. Whereas in the vse and exercise of Artillerie, the principall thing required is Art and Skill how to direct and bend the same vnto the assigned seruice: without which they doe altogether worke in vaine. Thirdly, the proper vse of other engins, is either to draw some thing vnto them as Capstayne doe to thrust or to remooue some thing from them, as Skrewes to heaue vp, as Pumps and Pulleyes, or to presse downe as Presses, &c. which most commonly serue at home for priuate vses, whereas *Artillerie* serueth to shoote and cast foorth Bullets, Balles, Arrowes, Darts, Stones, and diuers sorts of Shot, seruing for the publike warres both at home and abroad, aswell defensiuely to repulse and destroy the assaulting Enemy, as offensiuely to spoyle, kill, annoy, beat and weaken the Common Aduersary in his Towns, Forts, Armies, Fleetes,

Fleetes, Shippes, Ports, Subiects and deſignes. Artillerie therefore according to the times may be diuided into two ſorts: namely, Ancient and Moderne. Each of which according to Magnitude may bee againe ſubdiuided into two ſorts alſo; namely, Great and Small. The Antient Great Artillerie were the *Catapult*, *Baliſta*, *Scorpion* and *Ram*, The Antient ſmall Artillerie, the Long-bow, Croſſe-bow, Sling, & Slurge-bow. The Moderne great Artillerie are the great Ordnance, being the principall Subiect both of this and the former Treatiſe, which in their places are at large particularly deſcribed, & diſtinguiſhed; herein the ſmall moderne Artillery are, the Long-bow and the Hand-gunnes. As the Harquebuſe, Musket, Caliuer, Carbyne, Petronell and Piſtoll, the particular vſes of them as they appertaine, not neceſſiuely to the Gunners Office to mannage or practize, being no way exacted fro any accounted within the compaſſe of the *Traine of Artillerie*: So I therefore forbeare to ſay much of them referring their Practiſes and Poſtures to the iuditious inſtructions of Valiant and Worthy Gentlemen, who haue delighted in the profeſſion, vſe, and practiſe of thoſe Armes. For the Long-bow, although it be now growne ſomewhat out of warlike vſe, ſince the inuention of ſmall gunnes, yet bowes and arrowes being both ancient and generall warlike inſtruments, and were of two ſorts, *viz.* the Long-bow and the Croſſe-bow. The Long-bow is ſo wel known that it needeth no deſcription: which doubtleſſe of the two it was firſt inuented and practiſed in the Warres, as being the more ſimple Engine of the twaine, whoſe antiquity is ſurely very great, and ſeemeth to haue beene before *Noahs* Flood: For Almighty God promiſing to *Noah* and his ſonnes, that hee would no more deſtroy all fleſh with the waters of a flood, he giueth the *Rainebow* for a ſure token thereof, which hee there called his Bowe, diſtinguiſhing the ſame from mens bowes, as things then familiarly knowne to *Noah* and his ſonnes. And as it is ancient, ſo it is alſo of great force, by reaſon that all things therein almoſt doe worke *ſecundum naturam*. For firſt the Naturall and proper worke of the Chords, ſinewes and ligaments of Mans arme are to draw and pull vnto it ſelfe, rather then to relate themſelues to thruſt off. Secondly, the matter whereof the Bow is made, be it of wood or ſteele, by nature ſtiffe and ſtarke, being bent with the ſtring and drawne compaſſe with the arme, whilſt it flyeth out to the ſtraightnes which it naturally hath, and ſo fulfilleth his naturall worke. Thirdly, the Arrow artificially made, and proportioned to the ſtrength of the Bow eaſily hangeth in the ayre, and ſwiftly and gently ſlideth through the ſame. The generall vſe of it in all warlike nations may appeare, That the bow was in ſpeciall vſe among the *Hebrewes*. Many places of Scripture verifie, and the place of their ſeruice was in the Front of the battle; and amongſt the Philiſtims, for *Saul* was ſore wounded with the ſhooters of the Philiſtims. And amongſt the *Egyptiãs*, king *Ioſias* was hurt with the ſhooters of *Pharo Necho* king of *Ægypt*: & amongſt the *Aſſyrians*, *Achas* was ſlain with one of their arrowes: amõgſt the Citizens of *Rabbah* the *Amonites* their ſhooters ſhot from their walls againſt the army of *Ioab*: amongſt the men of *Cedar*, *Arabians* and *Iſmaelites*, whoſe ſtrong archers God threatneth ſhould be fewer. Amongſt the *Lidians* whom God calleth forthwith their Bowes againſt the diſobedient children of *Iuda*: amongſt the *Aſſyrians*; *Holophernes* hauing in his army 12000 archers on horſe

Mach. 9. 11.
Tit. Liu. lib. 7.
Chron. 25. 23.
.24.
Eſay 21. 17.
Ierem. 46. 9.
Iudeth 2. 15.

backe. And to bee ſhort, if wee ſhall reade the ancient Hiſtories of the Greekes and Romanes we ſhall finde the bow and arrowes euery where ſo vſuall a weapon, that moſt nations haue continually vſed them: amongſt whom our Engliſh Nation hath beene equall to the beſt, as all Chriſtendome can beare vs witneſſe in many battles; eſpecially that which our Nation did for *Ferdinand* king of *Caſtille* vnder the leading of the Earle of *Bedford*, who with 10000 Engliſh bow-men, armed beſides their bowes and arrowes, with battell-axes that hang at their backes, whereby he obtained ſo great a victory, that he & his ſucceſſors haue euer ſince carried the ſheafes of arrowes, and the long-bow in their ſhield, and alſo on their coyned halfe Royalls.

The ſecond ſort of Bowes is the Croſſe-bow, which *Titus Liuius* calleth *Scorpionius modicum*, partly by reaſon it hath the likeneſſe of that beaſt when the arrow is placed therein, and partly by reaſon of the like manner of hurting, watching all occaſions when and where to ſtrike ſureſt.

Chap. II.

Wherein is diſcourſed who were the Inuentors of Gunnes and Gunne-powder.

HAuing vndertaken in the former booke, called the Art of Great Artillerie, to ſhew by *Definitions*, *Theoremes*, and certaine *Queſtions*, the *Speculatiue* part of the *Art* of a *Canonier*, I haue now alſo thought fit in the ſecond part by the rule of reaſon to demonſtrate the Practicke part thereof, and to deſcribe all ſorts of Ordnance, aſwell ſuch as are, and haue beene vſed in forreigne Nations, as thoſe that are founded in England, and both the ancient and the moderne of both: wherefore I hold it needfull for compiling of the whole worke as compleate as I can, to declare by whom, and how this ſo diuelliſh an inuention was firſt brought to light. *Vffano* reporteth, that the inuention and vſe aſwell of Ordnance as of Gunne-powder, was in the 85 yeere of our Lord, made knowne and practized in the great and ingenious Kingdome of *China*, and that in the Maratyne Prouinces thereof, there yet remaine certaine Peeces of *Ordnance*, both of *Iron* and *Braſſe*, with the memory of their yeares of Foundings ingraued vpon them, and the Armes of King *Vitey* who he ſaith was their inuentour. And it well appeareth alſo in ancient and credible Hiſtoryes, that the ſayd King *Vitey* was a great Enchanter and Nigromancer, who one time (beeing vexed with cruell warres by the *Tartarians*,) coniured an euill ſpirit that ſhewed him the vſe and making of *Gunnes* and *Powder*: the which hee put in Warlike practiſe in the Realme of *Pegu*, and in the conqueſt of the *Eaſt-Indies*, and thereby quieted the *Tartars*. The ſame being confirmed by certaine *Portingales* that haue trauelled and Nauigated thoſe quarters, and alſo affirmed by a letter ſent from Captaine *Artred* written to the King of *Spaine*: wherein recounting very diligently all the particulars of *Chyna*, ſayd, that they long ſince vſed there both Ordnance and Powder: and affirming further,

that there hee found ancient ill-ſhapen Peeces, and that thoſe of later Foundings are of farre better faſhion and mettall then their ancient were. Some alſo imagine that Powder and Ordnance were inuented by the famous Mathematitian *Archimedes*, who made vſe of them at the ſiege of *Syracuſa* in *Cicillia*, and they ground that ſuppoſition vpon *Vitruuius*, who reporteth that one of his engins with a terrible noyſe did ſhoote foorth great Bullets of ſtone: which by reaſon of that report could neither bee ſuppoſed the *Catapulta*, *Baliſta*, *Scorpion*, nor any other of his knowne engins. Others ſay that Ordnance and Powder were vſed in the time of *Alexander* the Great, who hauing a purpoſe to beſiege a City neere the riuer *Ganges*, was diſwaded from it by ſome of his good friends that told him, the Citizens thereof were ſo much fauoured of *Iupiter*, that he vſually ſent *Lightning* and *Thunder* from their walles, that deſtroyed whoſoeuer offered to aſſault that City. And indeede if we ſhall well conſider the nature and effect of Powder and Ordnance, we ſhall finde them to come ſo neere vnto natutall thunder and lightning, that I thinke we may well ſay, that as Nature hath long time had her Thunder and Lightning, ſo Art hath now hers. *Dioniſius Halic* in his firſt booke of Antiquities reporteth, that *Alladius* the 12. King of the *Latins* after *Æneas*, had inuented a meanes by art to counterfeit Thunder and Lightning, of purpoſe to make his Subiects beleeue him to be a God, yet in the practiſing thereof he burned his houſe and himſelfe together, each of which may be probably coniectured to be done with the materialls of Powder and Ordnance. Others affirme that a Monke of *Germany*, named *Barthold Sheuuart*, otherwiſe called the Blacke. Vpon a certaine time (not thinking vpon Powder or Ordnance) in the yeere of our Lord 1300, hauing in his Morter a mixture of Sulpher and Niter for another vſe; by chance a cole of fire falling into the ſame, cauſed it ſo to rarifie and blow it ſelfe away: that hee beeing therewith aſtoniſhed, ſearched into the cauſe therof, & vpon further tryalls, he found that the hot and dry qualities of the Sulpher being with coale and moyſture combined and wrought together, with the cold and moyſt qualities of the Nyter, was apt by force to be ſodainly vnloſed with great rarefaction, wherby by little and little he brought that vnhappy inuention of Gun-powder and Gunnes to perfection, to make vſe thereof in Warres: which he reuealing in ſhort ſpace made it common. *Beraldus* ſaith, that at the firſt inuention of Ordnance they were all called by the name of *Bombards* (a word compounded of the verbes *Bombo*, which ſignifieth to Sound, and of *Ardeo* to burne) and they that vſed them, they called *Bombardiers*, which name is yet partly retained. After which, as *Bertholdus* ſaith, they were called *Turacio* and *Turrafragi* of the breaking downe of Towers and Wals: and by *Iohn de monte Regio*, they were called *Tormenti*: their Shot *Sphæra tormentaria*, and the Gunners *Magiſtri tormentorum*, But now Ordnance are eyther named at the will of the inuentors, either according to his own name (as the Canon was) or by the names of birds and beaſts of prey, for their ſwiftnes, or their cruelty: as the Faulconet Faulcon, Saker and Culuering, &c. for ſwiftneſſe of flying, as the Baſiliske, Serpentine, Aſpike Dragon, Syrene, &c. for cruelty, whoſe ſwiftnes, report, and terriblenes is properly and wittily expreſſed by the Latin Poet *Forcaſterius*, as followeth.

Con-

Continuo cana terrificis horentia bombis
Aera & flamifferum, tormenta imitantia fulmen,
Corripiunt, Vulcane tum dum Theutonas armas
Iuventum: dum tela Iouis mortalibus aſers
Nec Mora, Signantes certam ſibi quiſque volucrem
Incluſum ſalucrum cineres, ſulphurq; nitrumq;
Materiam accendunt, Seruata in veſte fauilla
Fomite correpta diffuſa repente furit vis
Ignea circumſepta: Simulq; cita obice rupto
Intruſam impellit glander volat illa per auras
Stridula et exanimes paſsim per Prata iacebunt
Deiectæ volucres, magno micat ignibus Aer
Cum Tonitru: quo Silua omnes Ripaq; recuruæ
Et percuſſa imo ſonuerunt æquora fundo.

Imitated by the Author, in Engliſh thus:

What Horrid roares proceed from *Bombards* ſoules
By ayre made fire, *Torments* of lightning flaſhes
From earth exhald, with vapours: *Vulcan* howles
For that now on earth men can make thunder daſhes,
Ingenious Art now Aping Natures worke,
Giues alſo name of birds and beaſts of pray
To Gunnes, wherein maine cruelty doth lurke,
When powdred *Peter*, *Coles* and *Napths* aſſay
To force the Sphæricke ſhot t'outflye Report,
And by Report to make the Welkin roare,
And Siluan cauernes, *Echoes* lowd retort,
Batter, Sinke, Kill, yet ayming miſchiefes more:
For *mercileſſe* they'l ſpare nor high nor low,
Poore, fatherleſſe, nor widdowes will they know.
The deuills birds I thinke were fitter names
To call them by, that ſpit ſuch cruell flames.

R. N.

Chap. III.

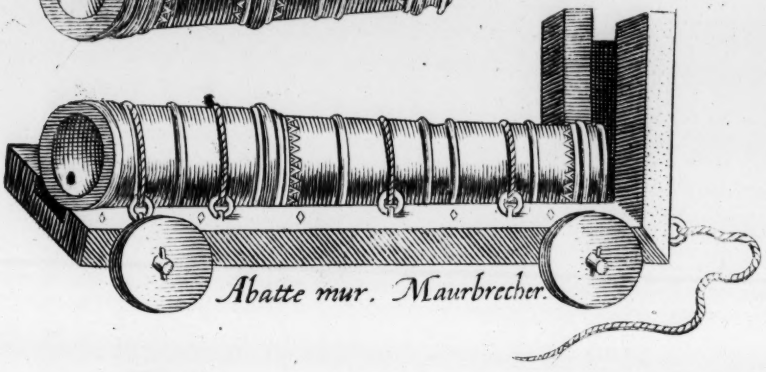
Where Ordnance were first vsed in these parts.

Paulus Interianus the *Ligurian* Historiographer, a graue and authentick Author writeth, that in the yeare of our Lord 1366. when the Warres were hot betweene the *Venetians* and the *Genoueses*, certaine *Germaines* presented two Peeces of Iron Ordnance (wrought by hand) vnto the *Seignory* of *Venice*, with some prouision of *Powder* and *Leaden Shot*; who receiued them very thankfully; especially seeing how that diabollicall vnknowne furie had not onely exceedingly feared, but also slaine so many of their Enemies, that thereby they preuailed and obtained a wished victory against their aduersaries, and accordingly got their owne deseignes. And *Paulus Iouius* in his third booke reporteth, that the first Field Ordnance that were vsed in *Italy*, were in the Warres betweene the *Bannitoes* of *Florence*, and the house of *Medices* brought by *Bartholmeo Coglioni*, and that the Prince of *Ferrara* hauing receiued a hurt in his foote by a Shott, from one of those small Peeces (mounted vpon wheeles as hee noteth.) The Prince earnestly complained, that *Coglioni* had behaued himselfe that day very maliciously against him, by vsing supernaturall Barbarisme, in making such horrible and vnaccustomed Tempests, to beat and spoyle his Men with, who had none other Weapons to defend themselues, but onely Swords and Speares. *Laonicus Chalon* in his fifth booke, reporteth that *Mahomet* the great Turke at the Siege of *Constantinople*, in the yeare of our Lord 1419, planted against it one peece of Ordnance, that he discharged seuen times in one day, which conueyed a bullet of 300 pound waight, and made the ground tremble a furlong round about it (at the discharge) with the report thereof. And he further affirmeth that the *Grecians* answered him againe with Peeces that shot bullets of 150 pound waight. *Polidor Virgill* in his fifth booke of the English History writeth, that in the yeere of our Lord 1425, in the beginning of the reigne of the French King, *Charles* the seauenth, the English hauing besiedged the Towne of *Mantz* so battered the walles thereof, that they soone fell to the ground. And *Munster* in his second Volume writeth, that the Duke *de Barre* 1431, was defeated by the Count *de Vademont*, by meanes of the Ordnance that he vsed (both Canon and Culuering) which was a matter then so new and rare, that the Count himselfe at the shooting them off, fell alwayes on his face to the ground for feare. Ordnance were also vsed by the *Almaines* about the Coast of *Denmarke* in the yeare 1434. *Paulus Iouius* and *Guichardine* relate that *Charles* the eighth of France hauing vndertaken the Conquest of *Naples*, vsed Ordnance both in the Plaines, and vpon the tops of high mountaines. And the *Italians* that described his returne, said, that with his souldiers, he drew them vp ouer the tops of the *Appenyne* Mountaines, and so from place to place with admirable courage, where by reason of the steepnesse and roughnesse of the place, horses and cattell could not bee imployed to draw them, but his horsemen did then carry the Shot & other Munitions to them belonging

α

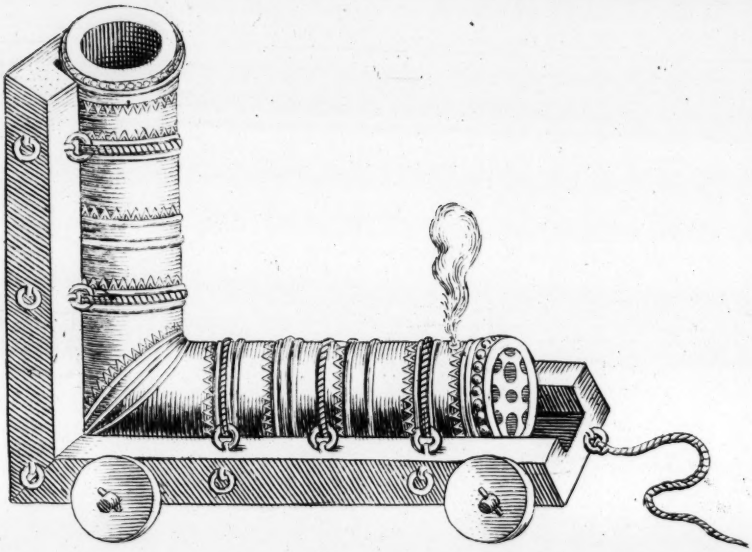
1

2



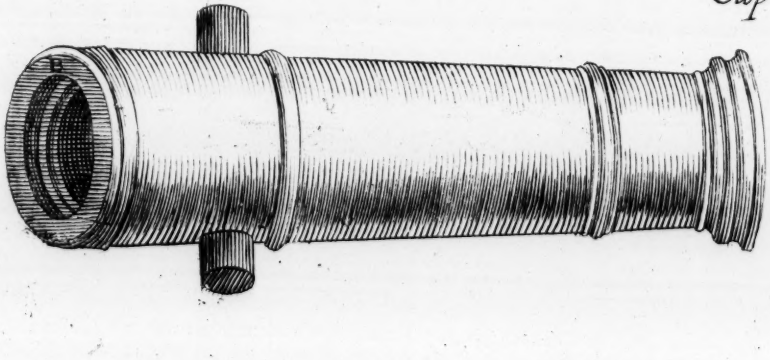
Abatte mur. Maurbrecher.

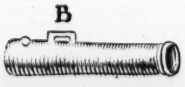
3



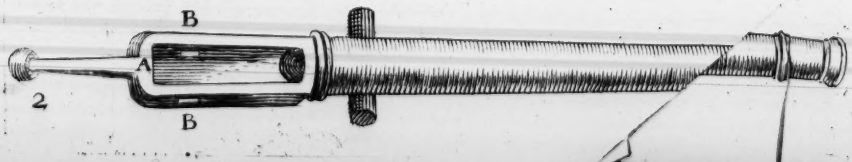
V

Cap. 5.





2



Ca. Pierrier ou Bombarde. Steinbuchse. I

ß

1

E[illegible]e a mire.

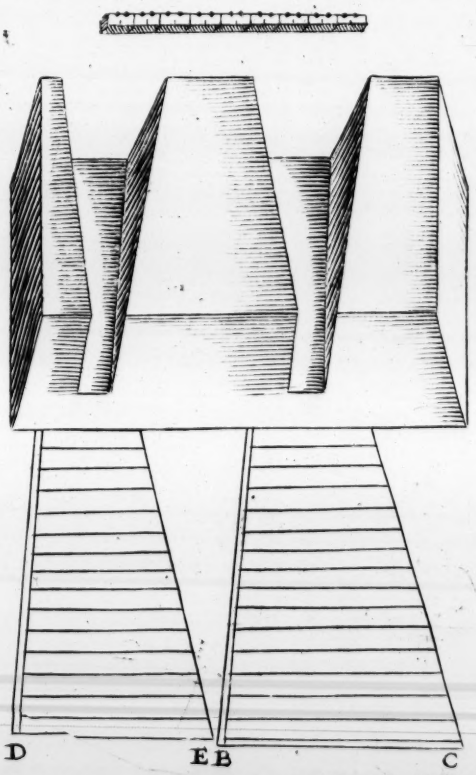
[illegible] leittern.

2

Tract. 2. Cap. 6.

Tr[illegible] l'esaulle auec ses croniers et [illegible]lanaes.

F[illegible] der schutren mitt ihren [illegible]n und britschen.



belonging, each of them a little. *Camello Vitelli* is said to haue inuented the Pistols and small Hand-gunnes for horsemen, whereby *Ferdinand* of *Aragon* discomfited the *French* and *Almaines*. Muskets were inuented for footemen, and first vsed at the Siege of *Rhege* in 1521 : since which time their inuentions haue been so infinitely varied as no man can fully expresse: which now shall suffice me, and I hope will giue satisfaction to other men also.

CHAP. IIII.

Of what formes and fashions Ordnance were first made.

CAptaine *Vffano* saith, that at the first inuention of Ordnance they made them of yron bars by hand, with yron hoopes, and of seuerall fashions, as may appeare in the precedent figure at α and β.

The first was like to the common drinking Cannes (vsed in *England*) tapring lesse & lesse towards one end. hauing also a tapering skrew at the breech to fasten it into a peece of timber : but the same growing wider and wider from the breech to the mouth-wards, made the Shot thereof to scatter and to be of little force and of lesse (and most vncertaine) direction : these long since are quite out of vse, and for their fashions they were called *Screwed Tapers*.

The second sort were called *A batte murs*, or *Beate walles*, and is represented therein at 2, they were not much vnlike *Bombards*, but were laide in Troughes or Trunke carriages with 4 truckes and two tymbers that rise vp at the breech to stay it in the carriage, and to performe the office of the Trunnions therein.

The third was called an *Elbow peece*, and is represented at 3 like a mans arme bended at the *Elbow* orthogonally, or at right Angles, whereupon it tooke that name, but it being also of little force, is likewise left and of no vse.

The fourth was a *Bombard* chambred which shot round stone shot, and is seldome (without alteration) vsed.

The fifth was called *Scala mur*, or the Scale wall, not much vnlike our Stocke fowlers, these two last are represented at 2 in the saide first figure β, differing onely in that our carriages which are made to mount, and imbase them by a sliding Standerd with holes and a trucke at the foot thereof.

And the sixt is like a Chambred Canon Perior, but that the Chamber is made of a Peece by it selfe skrewed into the Chase, and hath Truunions as is represented at *V1* in the first figure, but by reason of the great trouble to skrew it, the same is also out of common vse.

The seuenth Peece is nothing vnlike our Portingale-base, which with her Chamber, Tayle, and Hand stearne, to guide and direct it vnto the assigned marke, as is in the same figure represented at 2, being yet with vs of vse, especially in small vessells at Sea.

The three last they sometime did worke by Forge and Anuill, yet sometime they did cast the two first of these 3 both of Iron and brasse.

And thus much may serue to haue spoken of the Ordnance first formed of Antiquity.

Chap. V.

Of former forreigne Foundings of Ordnance.

GVnne-Founders about a hundred, or a hundred and fifty yeares past did vse to cast Ordnance more poore, weake, and much slenderer fortified then now, both here and in forreigne parts: also the rather because Saltpeter eyther being ill or not refyned, their sulphur vnclarified, their coales not of good wood, or else ill burnt; making therewith also their powder euilly receipted, slenderly wrought, and altogether vncorned, made it prooue to be but weake (in respect of the corned powder made now a dayes) wherefore they also made their Ordnance then accordingly, (that is much weaker then now:)for the powder now being double or treble more then it was in force of rarifaction and quicknes; requireth likewise to encrease the Mettall twice or thrice more then before for each Peece. For whereas then they allowed for the *Canon* 80 pound of Mettall for each pound that the Shot wayed, now they allow 200 pound & more for each pound of the Shot: and for Culuerings then they allowed but 100, and for Saker, Falcon, and lesser Peeces they were wont onely to allow 150 for one. But now for the Culuerings they allow 300, and for the small Ordnance 400 pounds, for each pound their seuerall shots of cast yron is to weigh. And as for forreigne Foundings that it may appeare how they differ from our English Ordnance, For I say that in *Spaine*, in *Germany*, and in *Italy*, they reckoning their *Canons* and *Culuerings* by the weight of their yron cast shot, they make at the least tenne sorts of eyther. For they haue *Canons* of 16,20,30,40,50,60,70,80,100, and 120, and *Culuerings* of 14, 20,30,40,50,60,70,80,100, and 120, calling them Canons or Culuerings of so much as their Shot weigheth, hauing seuerall heights of their Diametres, wherein although the Canon of 20 or of 30,&c. shoote yron shots of equall weight, with the Culuering of 20 or of 30 being of like numeration, and also of like height of Bore, for the *Cannon* of 30, shooteth a Shot of 30 pound waight, and so likewise doth the Culuering of 30, & the like is to be vnderstood of the Canon and Culuering of 50,60,80, or of 100 pounds, and so of the rest: yet doe they differ in the length of their Chases and fortification of their Mettalls, for the Canons are but about 18 Dyametres of their Bores in length, whereas their Culuerings are about 32 Dyametres of their Bore long. And besides they likewise differ in fortification of Mettall, : the ordinary Canon being in her Chamber but $\frac{2}{3}$ of her bore; and at her Trunnion but $\frac{1}{2}$, and at her Mouth but $\frac{1}{3}$ of her bore in thickne sse of Mettal, whereas their ordinary Culuerings are fortified with the whole height of their Bores in their Chamber and with $\frac{1}{2}$ at the Trunnions, and with $\frac{1}{16}$ of the height of their bores, at their Mouthes in thicknes

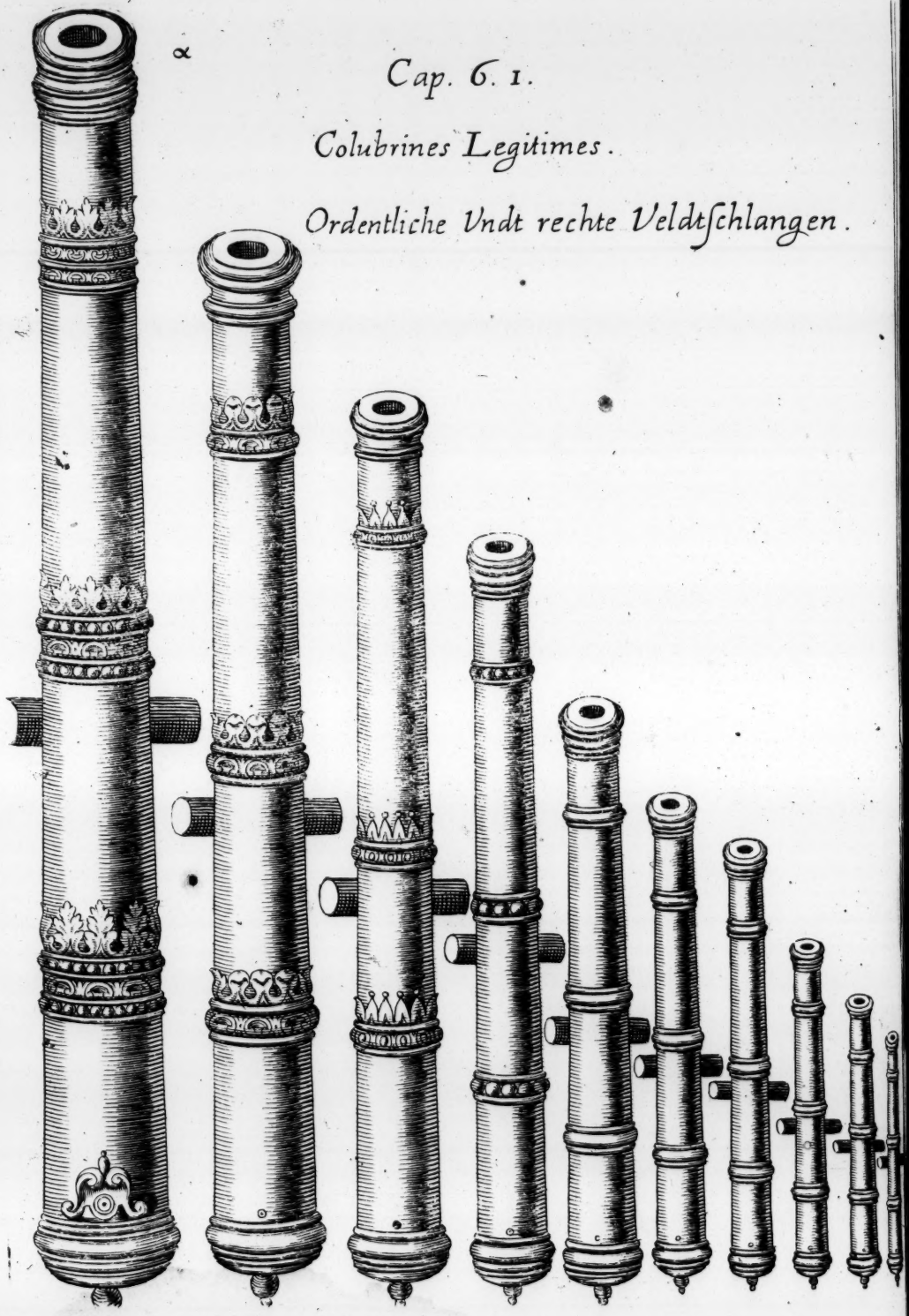
16
DEC

α

Cap. 6. 1.

Colubrines Legitimes.

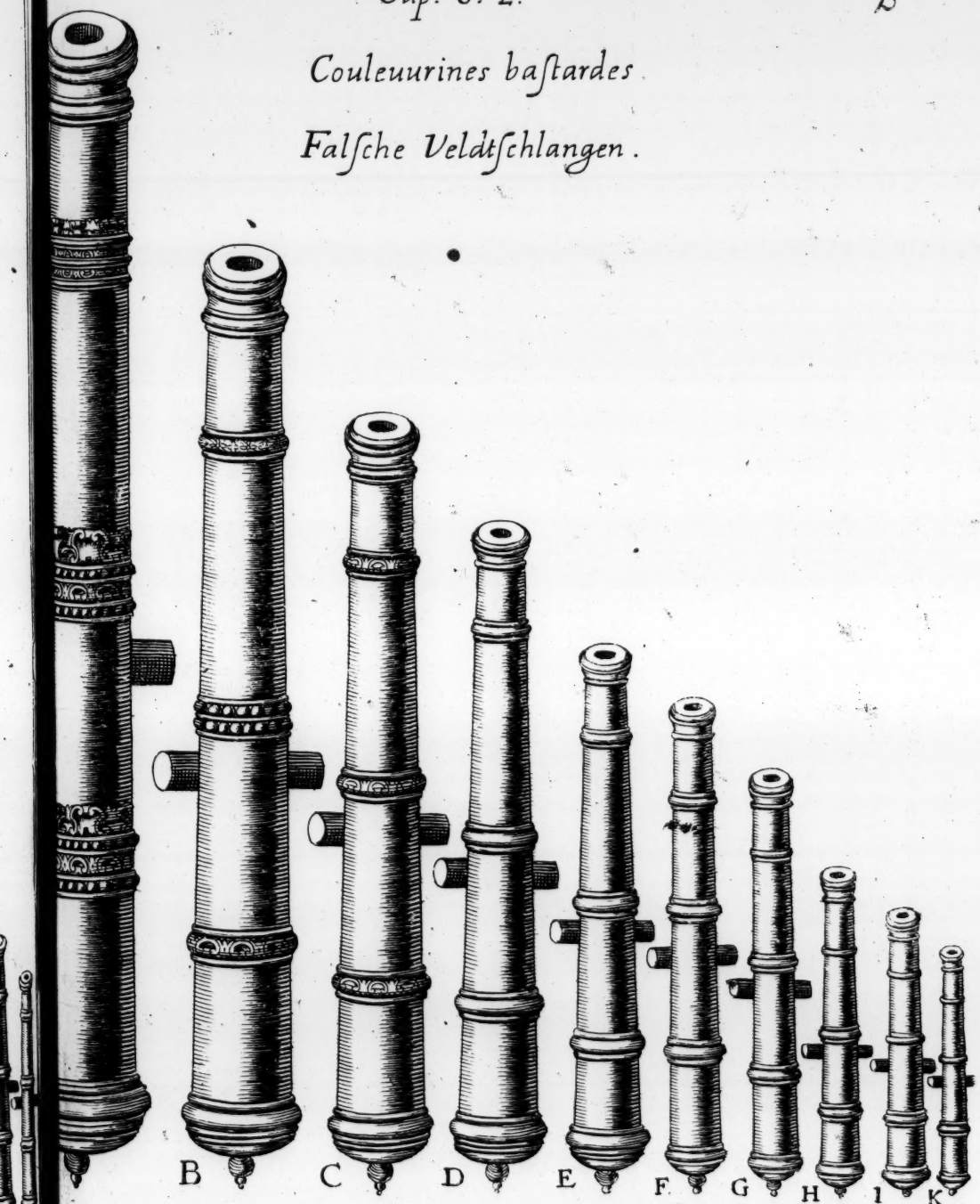
Ordentliche Vndt rechte Veldtſchlangen.



Cap. 6. 2.

Couleuurines baſtardes

Falſche Veldtſchlangen.



thickneſſe of mettall. Now becauſe the Meaſures and Weights in thoſe aforenamed Dominions doe not agree at all with ours, their pound Troy being about one ounce and a halfe lighter then our pound Haberdepoyz, and their feete and inches *Braſes*, and *Palmes* likewiſe differing among themſelues, and much more from our meaſure of foote and inch of Aſsize in *England*, as may appeare by the Scale here annexed, with the ſeuerall Tables; both theirs and our Ordnance are better to be diſtinguiſhed & vnder-

	Viena 6 *a Pace*
	Venice & Verona 8 *a Pace*
	Grecia 10 *a Pace*
	Bauaria 6 *a Pace*
$\frac{1}{4}$ *Of a foote in*	Antwerp 10 *a Pace*
	Ferrara 8 *a Pace*
	Loraine 10 *a Pace*
	Fraunce *du Roy* 8 *a Pace*
	England 20 *a Geo: Pace*

A Table of Heights.

lb.	inch.
14	$4\frac{1}{4}$
16	$4\frac{2}{7}$
20	$5\frac{1}{4}$
30	6
40	$6\frac{4}{5}$
50	$7\frac{1}{3}$
60	$7\frac{2}{9}$
70	8
80	8
190	9
120	$9\frac{1}{8}$

ſtood in their Weights, Bores, and Meaſures, then many words can explaine, I haue firſt therefore wiſhed, that my Brethren and louing countrimen (Engliſh Canoniers) ſhould be alſo acquainted with thoſe forreigne Ordnance; leſt perchance being commanded to ſerue with ſome of them, they vnhappily ſhould at firſt be dangerouſly miſtaken therein: wherefore I haue likewiſe here annexed a Table, which will neerely reduce the Spaniſh heights vnto our meaſures of inches, and for the reſt in regard their weights are ſo nigh one & the ſame among themſelues in the pounds, & differing from our pounds Haberdepoyze, &c. it may alſo tolerably ſerue for them all in like ſort, as the two examples following will I hope ſatiffie.

Example 1.

Admit there be a forreigne *Canon* or *Culuering* of 40, and the height of the Bore thereof be required.

Looke in this Table againſt 40, where you ſhall finde $6\frac{4}{5}$, ſo you may conclude that the Bore thereof is to bee 6 inches $\frac{4}{5}$ of our *Engliſh* Meaſures.

Example.

Example 2.

And in like manner for a Canon or Culuering of 60, you may finde ſeuen inches and $\frac{1}{9}$. But you muſt remember to allow $\frac{1}{4}$ part of that height leſſe, for the height of each ſhot, for the due vent thereof, as ſhall hereafter bee further ſhewed.

Wherby you may alſo perceiue that the wonted allowance of $\frac{1}{7}$ of an inch for the ſhot lower then the Bore of the Peece: for all Peeces Great and Small is no good proportion for allowing the vent generally, being but a generall *Engliſh* error, and reiected by vnderſtanding Gunners, as hereafter when we ſhew how to finde the due vent for euery Peece ſhall more at large appeare.

In *France* they haue vſually theſe 6 Peeces. *viz.*

	Bore. *deg.*	*Leng.* *d.*	*Shot.* *lb.*
Canon	6	19	33
Culu.	5	27	16
Baſt.	4	28	$7\frac{1}{2}$
Mini.	$2\frac{1}{4}$	36	2_{2}
Falc.	$2\frac{1}{2}$	36	$1\frac{1}{2}$
Falconet	2	37	$\frac{1}{4}$

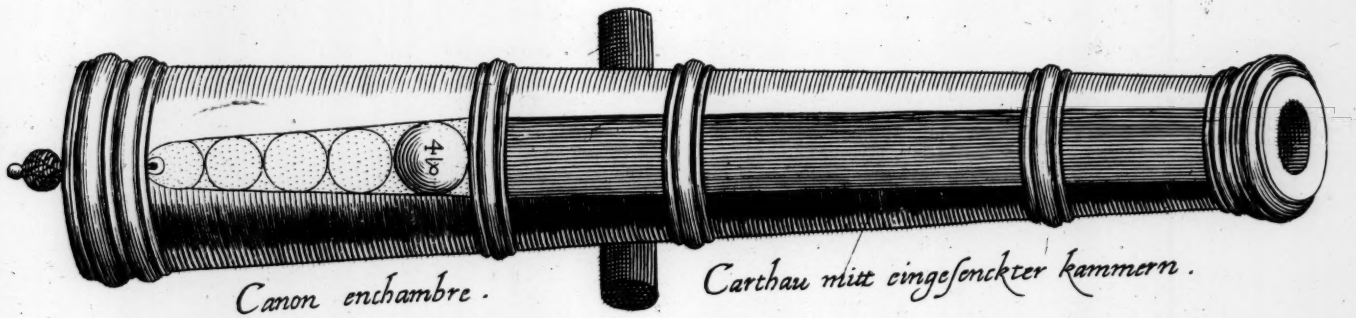
And 3 ſorts of Shot, Stone, Iron and Lead, whereof the firſt is to the ſecond ſubtriple, and the ſecond to the third *Subſeſquitret* in waight.

CHAP. VI.

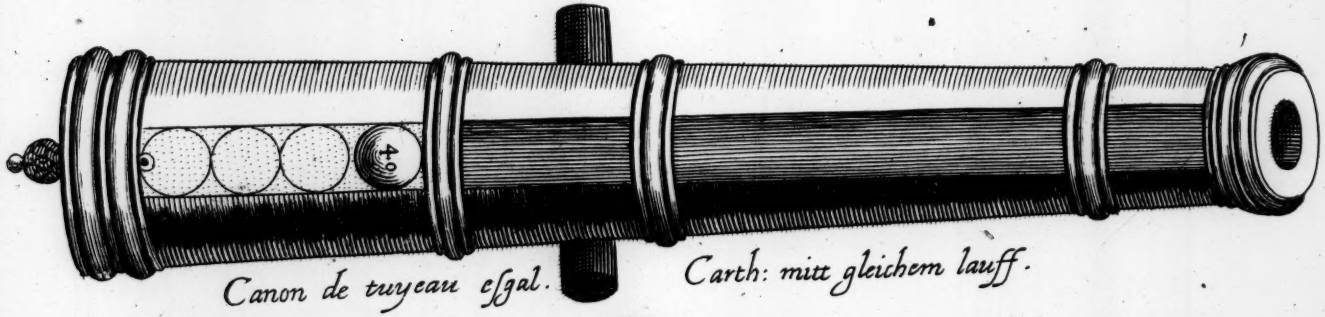
Of later Founding for legitimate Ordnauce.

THe *Emperour Charles* the fifth, finding the great inconuenience in thoſe confuſed varieties, conſulted thereof with his Councell of Warre, and thereupon commanded, That all his Gunne-founders ſhould thenceforth caſt all *Cannons* of 18 Dyametres of their *Bores* in length, and to carry an iron Caſte ſhot of 45 pound and allowed about 7000 waight of *Mettall* for euery of thoſe common *Cannons* for Battery: but for re-inforced *Cannons* (that is as we tearme them double fortified *Cannons*) to giue them one height of their Bore in thicknes of Mettall at the *Touch-hole*, and $\frac{11}{16}$ at the *Trunnions*, and $\frac{7}{16}$ at the *Mouth*, and to be alſo in length 18 Dyametres of their Bore, waying in Mettall about 8000 pound. But for leſſened *Cannons* being of like length he allowed but 6000 pound of Mettall, being $\frac{1}{4}$ thicke at the *Touch-hole*, $\frac{2}{16}$ at the *Trunnions*, and $\frac{1}{16}$ at the Mouth.

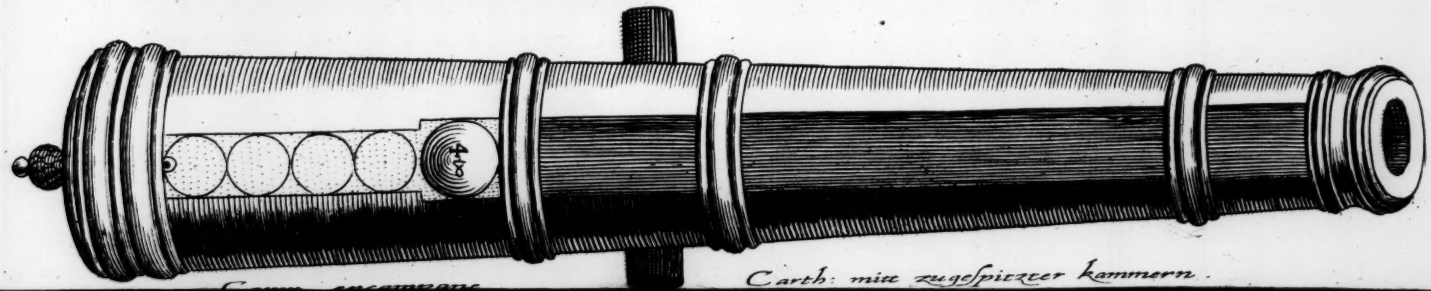
Whereupon theſe obſeruations may well ariſe, That each ſort of Ordnance



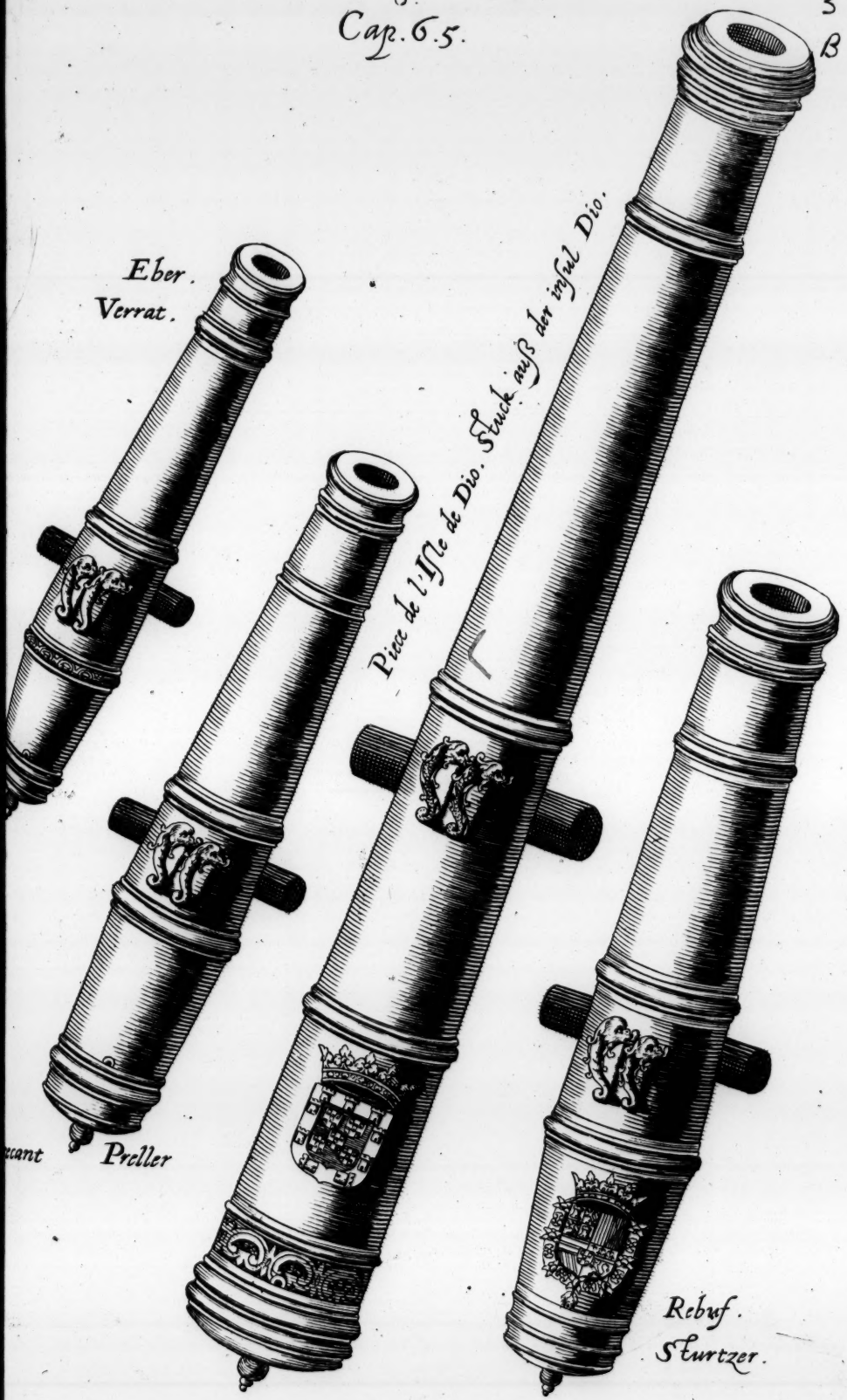
Canon enchambre. Carthau mitt eingeſenckter kammern.



Canon de tuyeau eſgal. Carth: mitt gleichem lauff.



Carth: mitt zugeſpitzter kammern.


Eber.
Verrat.
Piece de l'Isle de Dio. Stuck auß der insul Dio.
Preller
Rebuf.
Sturtzer.

nance that are re-inforced or double fortified, being thicker or richer in Mettall both in their Chambers and Chases then the ordinary or lessened are, therefore able to beare and resist the force of more Powder to be fired in them then the others can, without danger, and so consequently doe greater execution against any strong resisting Obiect. And likewise wee may conceiue that the ordinary fortified Pieces may endure more, and do more seruice then the Lessened can doe.

Monsieur de Alot, Don Louis de Valasco, and *Cond de Bucquoy*, late Generalls, or Masters of the Ordnance to the King of *Spayne*, considering the vtility and benefit of these Imperiall Orders, euery of them in their seuerall times gaue command to the Founders, that they should thenceforth cast all their Ordnance according to the proportions and Rules following.

Namely, that euery Ordinary *Canon* of battery should be made to shoote an yron round cast shot of 48 pound waight, with 24 pound of fine powder, or 27 of common powder, and to be in length 18 Dyametres of her bore, and fortified in thicknes of Mettall with $\frac{7}{9}$ in her Chamber, and with $\frac{1}{9}$ at the Trunnions, and with $\frac{1}{7}$ at the Mouth, waighing about 6500 pound.

The re-inforced or double fortified Cannons to be fortified the thicknes of one Dyametre in Mettall at the Chamber or Piller of fire, at the Trunnions with $\frac{2}{9}$ of a Dyametre, and at the Mouth with $\frac{1}{7}$ of her bore, which were to bee charged with 48 pound shot, and 28 pound of fine powder, or 32 pound of common powder, and waighing about 7000 pound, being 18 Dyametres in length.

The Lessened *Canon* to bee $\frac{1}{9}$ of a Dyametre of her bore in thickneſse of Mettall at the Chamber, and $\frac{1}{10}$ at the Trunnions, and $\frac{1}{16}$ at the Mouth, shooting 48 pound shot with 20 pound of fine powder, the Chase being also 18 Dyametres of her bore in length, and to waigh about 5700 pound.

And to make their *Demy-cannons* as the re-inforced to carry yron shot of 24 pound waight, to be 20 Dyametres of the bore in length of their Chases, and weighing about 4500 pound.

The Quarter Canons (re-inforced also) 25 times the Dyametre of their Bores in length, and the shot of 12 pound, and the peece to waigh 2700 pounds.

Likewise they gaue Order to cast their ordinary *Culuerings* 28 Dyametres of their Bores in length to shoote a shot of 16 pound, with 16 pound of ordinary powder, or 12 pound of fine powder: but for the Lessened with 14 pound of common, or 10 pound $\frac{1}{2}$ of fine powder; and the double fortified or re-inforced, with 18 pound of common, or 13 pound of fine powder. And their common *demy Culuerings* to be 30 Dyametres of their Bores in length, and more rich in mettall then the whole *Culuerings*, and their shot to weigh 10 pound, with 10 lb. of common powder, or $\frac{4}{5}$ of fine powder namely: 8 pound. And for the Lessened 9 pound of common, or 7 pound $\frac{1}{2}$ of fine powder: But for the re-inforced, 11 pound of common, or 8 pound $\frac{4}{5}$ of fine powder.

And their *Sakers* or quarter *Culuerings* to bee 32 Dyametres of their Bore for length of their Chases, and to shoote 6 pound of iron shot with as much fine powder as the shot waigheth: and the like for the *Faulcons*, *Faulconets*, *Rabinets* and *Bases* which may be from 36 to 50 Diametres of their Bores in

length, and the more fortified. And thus much for Moderne Legitimate Ordnance: as for Baſtard *Canons*, Baſtard *Culuerings*, &c. they ſhoote higher ſhot, but are in Chaſe fewer of their proper Dyametres in length. And for extraordinary Peeces they are of lower height in their Bores, and in Chaſe more their proper Dyametres in length, then the Legitimate are. And of both the Baſtard Peeces, and of the extraordinary Peeces there are *Common* fortified, re-inforced or double fortified, or leſſe, or leſſened fortified Peeces, aſwell as of the Legitimate: each of ſuch thicknes of mettall in euery member in proportion being compared with their proper Dyametres, as the ordinary, re-inforced, or Leſſened legitimate Peeces are of; as the particulars with their names, waights, and proportions here vnder mentioned, with the Tables following will make manifeſt.

Ordinary obſeruations in Venice.

A Peece being of 2 inches in height the ſhot waigheth 1 lb.

At 2 inches and $\frac{1}{2}$, 3 lb. $\frac{1}{2}$, At 3 inches 4 lb. At 3 inches one quarter 5 lb. At 3 inches and $\frac{1}{4}$, 6 lb. At 4 inches, 9 lb. At 4 inches and a halfe 11 lb. At 5 inches 16 lb. At 5 inches and a halfe 23 lb.

And note that all theſe ſhoote the full weight of their ſhot in powder. And alſo that their pound is but about 14 ounces Haberdepoy &c.

And their *Obſeruations* for their greater Peeces appeareth by the Table and diſcourſe following. *viz.*

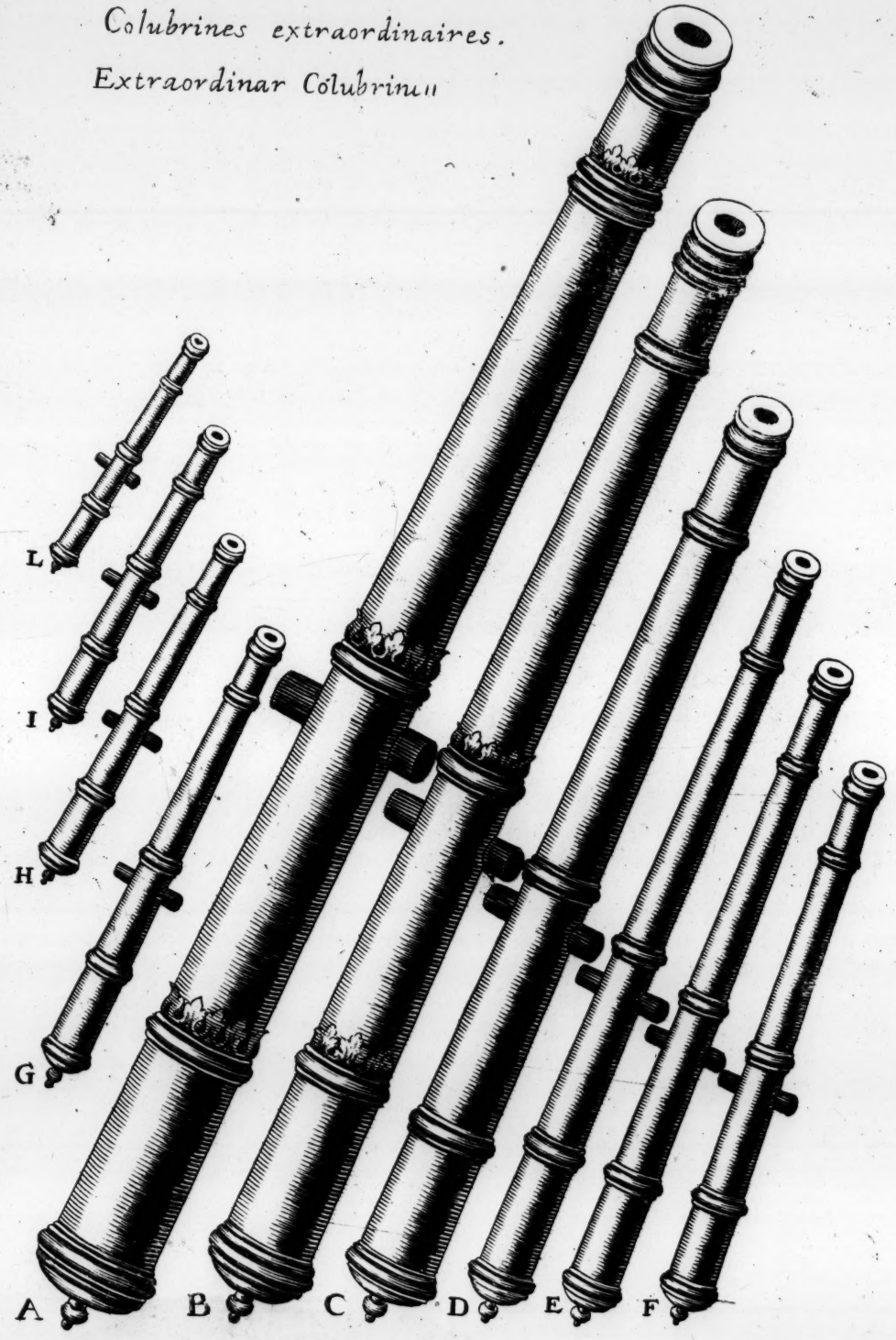
	Bore. *inch.*	*Shot.* *lb.*	*C Powd.* *lb.*
Canons of 6 inches	5 $\frac{1}{4}$	26	18
Canons of 7 inches	6 $\frac{1}{4}$	38	24
Canons of 8 inches	7 $\frac{1}{4}$	64	42
Canons of 9 inches	8 $\frac{1}{4}$	110	76
Canons of 10 inches	9 $\frac{1}{4}$	174	136
Canons of 11 inches	10 $\frac{1}{4}$	205	146
Canons of 12 inches	11 $\frac{1}{4}$	245	162
Canons of 13 inches	12 $\frac{1}{4}$	285	190
Canons of 14 inches	13 $\frac{1}{4}$	348	232

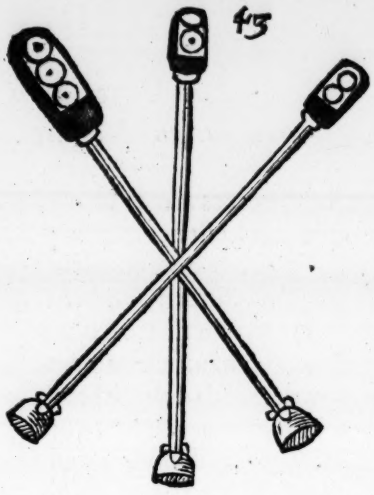
The Canons of 6, 7, 8, 9, and 10 inches they load with $\frac{2}{3}$ of powder of their ſhots weight and load with 3 ladles full of powder for their charge, each ladle 3 bals long. But the *Canons* of 11, 12, 13, and 14 inches, they load with 4 ladles full of powder, each ladle being 1 Dyametre and a halfe of the ſhot in length. As the figure following deſcribeth.

You

Colubrines extraordinaires.

Extraordinar Colubrinu.





You may alſo further vnderſtand, that for the 4 laſt mentioned *Canons*, the Ladle deſcribed in the midſt of this figure ſerueth, being but one Dyametre and a halfe in length of the ſhots height: whereof 4 Ladlefulls maketh vp 6 Dyametres, which is $\frac{2}{3}$ of nine which is alwayes accounted to containe waight for waight: namely, ſo much powder as will bee of equall waight with the iron caſt ſhot, aſwell for theſe as all other Peeces, which although it be not exactly ſo, yet may it ſerue for a generall eſtimate for a ſodaine ſeruice to gueſſe a neere proportion.

A Table of re-inforced Legitimate Ordnance.

		Weight	*Mir.Co.*	*Leu.*	*Beſt*	
A	The Dragon a Double Culuering	14000	714	357	4252	paces.
B	Whole Culuering	8500	630	315	3703	
C	Demy Culuering	4600	470	235	2796	
D	Saker or ½ Culuering	2650	366	183	2181	
E	Faulcon	1500	279	889	1659	
F	Faulconet	850	215	107	1280	
G	Rabinet	425	164	82	669	
H	Baſe	300	126	63	725	

A Table of Leſſened Legitimate Ordnance.

A	The Dragon or double Culuering	11000	650	325	3164	paces.
B	Whole Culuering	6300	570	285	3391	
C	Demy Culuering	3150	434	217	2558	
D	Saker	2000	334	167	1838	
E	Faulcon	1100	254	127	1514	
F	Falconet	600	196	98	1163	
G	Rabinet	350	150	75	895	
H	Baſe	300	180	40	842	

CHAP. VIII.

Of Foundings of Baſtard Peeces, with their Names, Waights, and Meaſures.

BAſtard Peeces are as I haue ſaid, Ordinary, Re-informed and Leſſened, namely the Ordinary of one Diametre of her Bore in thicknes of Mettall at the *Touch-hole*; Re-inforced of more then one Dyametre, and the Leſſened of leſſe then one Dyametre thick there: each of which haue the name, the waight, proportion of powder, and of the ſhot allowed as followeth.

The ordinary *Baſiliske* or *Baſtard double Culuering* is about 26 Dyametres in length, and ſhooteth an iron caſt ſhot of 48 pound, with 39 pound of Common, or 30 pound of fine powder, and weigheth 12200 pounds.

The *Serpentine* or *Baſtard Culuering* is in length 27 Dyametres of her Bore, and ſhooteth 24 pound ſhot with as much common, or 19 pound ¾ of fine powder.

The *Aſpike* or *Baſtard demy Culuering*, ſhooteth 12 pound ſhot, with 12 pound of fine powder, and is 28 Dyametres long, waighing 4050 pound.

The *Pellican* or *Baſterd quarter Culuering* is 29 Dyametres of her Bore in length ſhooting ſixe pound, with as much fine powder, weighing 2400 pound.

The *Baſtard Faulcon* ſhooteth 3 pound ſhot, with 3 pound of fine powder, and is 30 Dyametres long, and waigheth 1350 pound.

The *Baſtard Rabinet* ſhooteth an iron ſhot of 1 pound ½ with ſo much fine powder, and is 31 Dyametres of her Bore in length, weighing 750 pound. Theſe aforeſaid are Ordinary Baſtard Peeces for the Reinforced and Leſſened: the Table following will deſcribe.

A Table of Baſtard Peeces reinforced by Mettall.

		Waight	*by mettle*	*Leuell*	*Beſt*
A	Baſiliske	14660	659 *paces.*	329	3921 *paces.*
B	Serpentyne	8100	590	295	3511
C	Aſpicke	7600	440	220	2618
D	Pellican	2550	344	172	2044
E	Faulcon	1500	261	132	1553
F	Rabinet	800	202	101	1198
G	Baſe	450	120	72	916

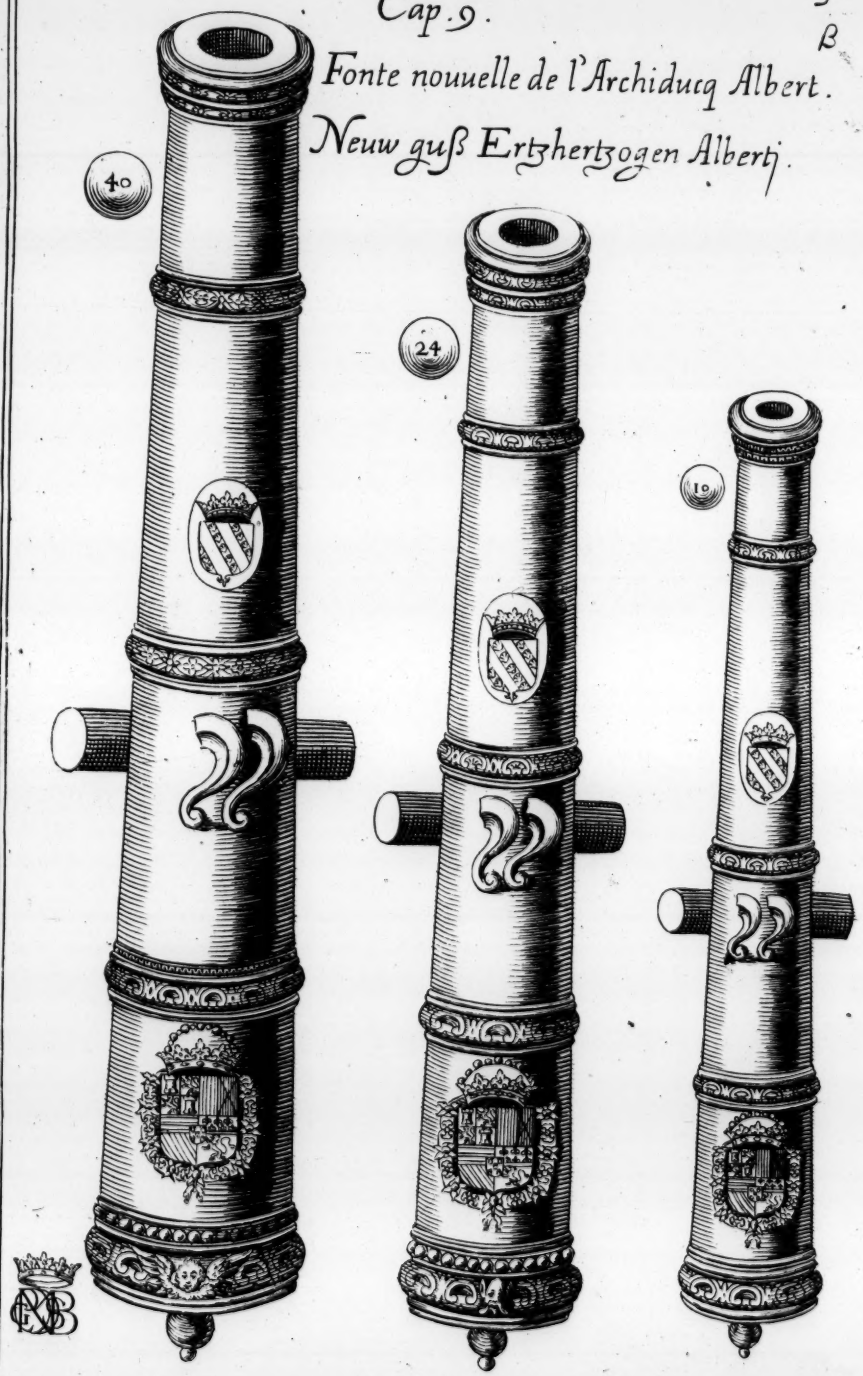
Canon de l'Emp. Charles V. dont deriuent les meillieures fontes.

Kaiß: Mt. Caroli V. Carthaunen nach Welchen die beste guß gerichtet sein.

Cap. 9.

Fonte nouuelle de l'Archiducq Albert.

Neuw guß Ertzhertzogen Alberti.



A Table of Bastard Peeces Lessened.

		Waight	*by mettle*	*Leuel*	*Best*
A	Basiliske	10500	595	298	3540
B	Serpentine	6300	530	265	3153
C	Aspyke	3700	400	200	2028
D	Pellican	2100	310	155	1844
E	Faulcon	1200	212	118	1407
F	Rabinet	650	182	92	1086
G	Base	155	139	70	825

Thus much for the Common fortified Peeces, and these Tables for Lessened & re-inforced, as well for Basterd as for extraordinary Peeces which will further satisfie the Reader in particulars then many words: which because they are plaine enough, I think they shall need no further explanation.

CHAP. IX.

Of Foundings of Extraordinary Peeces with their Names, Waights and Measures.

EXtraordinary Peeces hauing as I said, longer Chases, and lower heights of Bore then eyther the Legitimate or Bastard Peeces are neuertheleſſe of 3 sorts also; as the Ordinary fortified with one Dyameter thicke of Mettall at the Touch-hole, and the re-inforced with more then one Dyametre, and the Lessened with lesse then one Dyametre of their proper Bore in thicknes there at the Touch-hole, euen as we haue already said both of the Legitimate and Bastard Peeces also. And first the Ordinary haue the measures and weight following.

The Flying *Dragons*, ordinary or extraordinary *Double Culuerings* are of 29 Dyametres of their Bore in length of their Chases, and shoote 32 pound of iron cast shot, with 27 pound of Common, or 22 pound $\frac{4}{5}$ of fine powder, and waigh about 12200 pound, shooting by mettle, or *Mira Com.* 638, leuelleth 319 paces, best 3790 paces.

The *Syrene* or extraordinary *whole Culuerings* are 40 times in length, the height of their Bores, weigh 6900 pound, and shoote 16 pound iron shot, with 16 pound of Common, or 12 pound $\frac{4}{5}$ of fine powder, shooting by mettle 560 paces, leuell 250 paces, best 3332 paces.

The *Flying Sparrowes*, or extraordinary *Demy Culuerings* are in length 41 times the height of their Bores, shooting 8 pound iron shot, with 9 pound of Common powder, or 7 pound $\frac{1}{4}$ of fine powder, and waigh 4100 pound, shooting by Mettall 420 paces, leuell 220 paces, at the best Randon 2499 paces.

The extraordinary *Sakers*, or Quarter *Culuerings extraordinary*, are 42 times in length, the height of their Bores: and shoot, a shot of 4 pound of cast iron, with 6 pound of Common, or 4 pound ½ of fine powder, and weigh 2350 pound, shooting by Mettall 316 paces, leuell 158 paces, Best, 1941 paces.

The *Extraordinary Faulcons* haue 43 times the height of their Bores in length of their Chases, shooting 2 pound of iron shot with 2 pound of fine powder, and weigh 1350 pound, shoot by mettal 249 paces, Leuel 124 pac. Best 1481 paces.

The extraordinary *Rabinets*, or *Passengers*, are 44 times their Bore in length, and weigh 775 pound, shooting 1 pound of iron shot, or 1 pound ½ lead, with 1 pound ½ of Common, or 1 pound ¼ of fine powder, shooting by mettle 192 paces, Leuell 96 paces, Best 1142 paces.

The extraordinary *Bases* weigh 450 pound, and are 45 Dyametres, their shot are ½ pound of iron, or ¼ of Lead, with as much fine powder, shooting by the Mettall 147 paces, Leuell 74 paces, and at their best Randon 876 paces.

The Re-inforced and Lessened extraordinary Peeces are made apparant by these Tables following.

A Table of Re-inforced extraordinary Peeces.

	Flying	*By Mettall*	*Leuell*	*Best*	*Waight*
A	Dragon	658	329 *paces.*	3936 *paces.*	14000 *lb.*
B	Syrene	590	295	3511	81000
C	Sparrow	440	220	2618	4600
D	Saker	348	174	2044	2600
E	Faulcon,	261	130	1553	1500
F	Rabinet	202	101	1198	800
G	Base	154	77	916	500

A Table of Lessened extraordinary Peeces.

	Flying	*By Mettall*	*Leuel*	*Best*	*Waight*
A	Dragon	595 *paces*	297 *paces.*	3540	10500 *lb.*
B	Syrene	530	265	3153	6300
C	Sparrow	400	200	2018	3700
D	Saker	310	155	1824	2100
E	Faulcon	236	118	1407	1200
F	Rabinet	183	92	1081	650
G	Base	139	69	829	350

There rests yet another kind of moderne Forreigne Peeces inuented by *Iuan Mauriga Lara* that shoote onely Stone or Murthering Shot, which are onely Taper bored in their Chambers, not much vnlike our Drakes, whereof there were 3 sorts.

The first of them were 15 times the Dyametre of their Bore in length, and called *Rebuffes*.

The

The ſecond ſort were 16 times their Bores in length called a *Cracker*.
And the third were 17 Bores in length, and called *Ferrates*, all which are repreſented in the third figure at [B].

Theſe laſt mentioned (as alſo our *Drakes*) may eyther be reckoned among the ſorts of Canon Periors, (being they are neerer the length of Dyametres) but ſhooting iron ſhot, are neerer vnto the ſorts of Cannons of Battery: wherefore I conceiue they may properly bee eſtimated as Baſtards to the one, or els as extraordinary to the other of theſe ſorts, for the reaſons before alleadged. And thus much may ſuffice to ſpeake of Forreigne Founding.

CHAP. X.

Of our Engliſh Ordnance diſtinguiſhed into 4 kindes, and thoſe generally diuided into ſeuerall ſorts as followeth.

THe Ordnance that are vſually founded in England, may very fitly be diuided into foure ſeuerall kindes in reſpect of the height of their Bores, length of their Chaſes, Fortification of their Mettall, and the vſes for which they are to ſerue, whoſe differences each from other I here intend to ſhew in generall, beginning with the Greateſt; namely, the *Canons of Battery*, which we reckon to be the firſt kind, They differ very much from the other three kinds, as will appeare by comparing the height of their Bores, with the length of their Chaſes, The height of their Bores being all between 8 inches ½, and 6 inches Dyametre; and the length of their Chaſes being betweene 15 and 22 Dyametres of their proper Bores; in fortification of mettall they differ alſo, for that they neuer exceede one Dyametre of their Bores in thickneſſe of Mettall at the Touch-hole. They differ in vſes, as being onely vſed in Batteries, which the reſt are not except the Culuerings (which are ſometimes alſo vſed to pierce and cut out thoſe ruines that the Canons haue looſened and ſhaken) Cannon ſhot being heavieſt, becauſe greateſt, therefore onely and moſt fitly vſed to batter the *Enemies* Walls, Curtins, Bulwarks, and Defences: Of the Cannons of Battery there are three ſorts: Namely, the double Canon, or Canon Royall, or Canon of 8, whoſe Bore is 8 inches and vpwards, in the height of her Dyametre, and being 15 or 16 Dyametres long in her Chaſe; the ſecond ſort is called the *Whole Canon*, or Canon of ſeuen, being 7 inches in height, and about 18 Dyametres long. The third ſort of this firſt kind are the *Demy Canons*, of about 6 inches in height of the ſhot, and 20 or 22 Dyametres in length, Of this kind may alſo the *Minions* and *Drakes* be reckoned. Of the ſecond kind wee reckon the Culuerings and their Conſorts which

which are in height of Bore between 5 inches and $\frac{1}{2}$, and 1 inch $\frac{1}{2}$ Dyametre, and in length of their Chaſes they may be betweene 28 and 60 times the Dyametre of their owne Bores, and in fortification being neuer leſſe then one whole Dyametre of Mettall in thicknes at their Chãbers: Of this kind are many ſeuerall ſorts; namely, all ſuch leſſer Ordnance as ſhoote iron ſhot, As the double Culuering, the whole Culuering, Demy Culuering, Saker, Faulcon, Faulconet, Rabinet, and Baſe, &c. whereof I ſhall hereafter ſpeake more in particular. The ſmaller of this kind are of the more Dyametres of their Bores in length, and better fortified in thicknes of Mettall, each hauing alſo reſpect to their owne proper Bore. Of the third kinde are the *Periors*, or ſuch Peeces as onely ſhoote Stone, or els Murthering Shot, both which, and Fireballs may be likewiſe ſhot out of any of the aforementioned Ordnance. And there are alſo ſeuerall ſorts of Peeces of this third kind, all which are diſtinguiſhed from the Ordnance of the fourth kinde, for diuers reſpects, eſpecially for length, being 8 or more Dyametres of the Bore at the Mouth in length of their Chaſes. The ſorts of this kind are the *Canon Perier*, the *Periera*, the *Port Peece*, the *Stocke Fowler*, the *Sling*, *Bombard*, &c. of each of which more ſhall be ſaide in their proper places hereafter. Of the fourth kind are all ſort of Peeces that either ſhoote ſtone ſhot, Fireballes, Murthering ſhot, or els no ſhot at all. The ſorts of this kind are the *Morter Peeces*, *Murtherers*, *Pettards*, *&c.* being in length vnder 6 times the height of the Bore of their Mouthes, of each ſort of this kind ſome are bigger, and ſome leſſer according as the aſſigned ſeruice requireth.

A Table out of Alexander Bianco, *each pace two foote and a halfe for Randons of the 6 Poynts of the Gunners Quadrant.*

	Poynt Blanke.	1	2	3	4	5	6
Faulconet	180	750	1275	1590	1710	1785	1800
Faulcon	260	1100	1870	2332	2508	2618	2640
Minion	240	1000	1650	2046	2340	2412	2440
Saker	300	1250	2125	2650	2850	2957	3000
Demy Culuering	348	1450	2465	3074	3306	3451	3480
Culuering	360	1500	2550	3180	2420	3570	3600
Demy Cannon	312	1300	2210	2756	2964	3094	3120
Canon of 7	324	1350	2295	2865	2978	2213	3240
Canon of 8	360	1500	2550	3180	3420	3570	3600

This Table ſeemeth to bee Calculated after the Comon Pace, which is but $\frac{4}{5}$ if the Geometricall Pace, and muſt out of doubt be ſo vnderſtood, as he himſelfe in ſome part of his Booke acknowledgeth, which I thought fit to giue notice of to auoid miſpriſions, and for making the matter more plaine. Which the Reader may reduce by taking $\frac{1}{5}$ of euery number.

I haue here alſo added another vſuall Table for Engliſh Ordnance, wherein

wherein I acknowledge some errors are, because exactnes in Tables of this Nature is not to be expected, by reason of the infinite diuersities of Materialls and Accidents: But it may so become vsefull neuertheless, because it resonably pointeth at what should be in this matter expressed precisely, if it were possible, which the curteous Reader I hope will accept of vntill better come.

A Table of Ordinary proportions allowed for English Ordnance.

	Bore.	Height of the Shot.	Weight of the Shot.	Weight of Serpent: Powder.	Ladles length.	Ladles breadth	Length of the Peece.	Weight of the Peece.	Weight of Corne powder.
Canon Royall, or, Canon of	Inches 8	Inch. $7\frac{3}{8}$	lb. 63	lb. 40	inch. 24	inch. 14	foot. 12	lb. 8000	lb. 27
Canon of	7	$6\frac{3}{4}$	39	25	22	$12\frac{1}{4}$	11	7000	18
Demy Canon	$6\frac{1}{2}$	$6\frac{1}{4}$	30	20	21	$11\frac{1}{2}$	10	6000	14
Whole Culue.	5	$4\frac{3}{4}$	15	14	19	9		4300	10
	$5\frac{1}{4}$	5	$1\frac{1}{2}$	15	20	10	12	4400	12
	$5\frac{1}{2}$	$5\frac{1}{4}$	20	16	21	11		4600	15
Demy Culue.	$4\frac{1}{4}$	4	9	8	17	7		2200	6
	$4\frac{1}{2}$	$4\frac{1}{4}$	$10\frac{1}{2}$	9	18	8	11	2400	$7\frac{3}{7}$
	$4\frac{1}{4}$	$4\frac{1}{2}$	$12\frac{1}{2}$	10	19	9		2500	8
Saker	$3\frac{1}{2}$	$3\frac{1}{4}$	5	5	30	9		1400	4
	$3\frac{1}{2}$	$3\frac{1}{2}$	$5\frac{1}{2}$	$5\frac{1}{2}$	31	$9\frac{1}{2}$	9	1500	$4\frac{3}{4}$
	4	$3\frac{3}{4}$	$5\frac{1}{2}$	$5\frac{1}{2}$	32	10		1600	$5\frac{1}{2}$
Minion	$3\frac{1}{4}$	3	$3\frac{6}{4}$	$3\frac{1}{2}$	25	$5\frac{1}{2}$	$7\frac{1}{2}$	1200	3
Falcon	$2\frac{3}{4}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	22	5	7	700	2
Falconet	$2\frac{1}{4}$	2	$1\frac{7}{7}$	$1\frac{1}{2}$	18	$3\frac{1}{4}$	6	500	1
Rabinet	$1\frac{1}{2}$	$1\frac{1}{4}$	$\frac{3}{4}$	$\frac{3}{4}$	$11\frac{1}{2}$	$2\frac{1}{2}$	4	300	$\frac{1}{2}$
Base	$1\frac{1}{4}$	1	$\frac{1}{2}$	$\frac{1}{2}$	9	2	$3\frac{1}{2}$	201	$\frac{1}{4}$

For the *Culuerings* whose shot weigheth 18 pound, you must abate $\frac{1}{6}$ which is 3 pound, for then the powder must weigh 15 pound.

For the *Canon* abate $\frac{1}{7}$.

For a generall obseruation take that a Ladle 9 bals in length, and 2 bals in breadth, will very neere containe the iust waight in powder, that the iron cast shot for any Peece waigheth.

And also that the powder here mentioned is for Serpentine powder, which being now out of vse, the Corne powder being $\frac{1}{7}$ stronger, therefore $\frac{1}{7}$ of these weights is to be abated, as in the last Colume appeareth.

Chap. XI.

Of the Canons of Batterie in particular, or of the firſt kinde, and their ſorts.

IT would be too tedious and long, yea and almoſt impoſſible to ſhew all the differences and inequalities in the Weights and Meaſures of ſeuerall Peeces of one ſame kind and ſort of Ordnance that haue been caſt, or yet are at this time remaining in ſeuerall Fortreſſes of England and other countries, beſides ſuch as are here & there yet daily Founded or vſually made either according to the Princes and the Officers of the Ordnance inuention and wills, or ſome Founders opinions and ſelfe conceipts. But forasmuch as it is a matter of greateſt importance for euery *Gunner* that taketh charge of Ordnance, to know perfectly of what kind and ſort euery Peece that is committed vnto him to manage and ſerue with, is; and whether they be ſufficiently fortified or not, and to diſcerne and examine whether any defect be amongſt them, and ſo to be able thereby to iudge what powder each Peece in loading is able to endure, with ſafety to performe her vttermoſt ſeruices, conſidering then withall that Powder is now reduced into a greater perfection for force then formerly it was, wherefore former proportions are to be altered now: otherwiſe by ignorance or ouerſight they may more endammage their owne ſide then their Enemies. Some Peeces being but poorely fortified, are too long to beare a ſufficient loading, others are too too ſhort to burne their full charge of powder requiſite to carry their ſhot home to the aſſigned ſeruices; ſome are too light and, and ſome too heauy in their breeches, by miſplacing their Trunnions in making the mold for their foundings, being too light they danger the vawmures, and by being too heauy in their Mettall towards their Breech, they become vnweldie and troubleſome to *Manage*.

There are three ſorts of *Canons* of *Batterie*, namely, the *Canon Royall*, or double *Canon*, they are vſually 15 times in length, the Dyametre of their Bores, which is about 8 inches in height.

The next is the *Whole Canon*, or (as it is called) the *Canon* of 7, being about 7 inches in Dyametre of Bore, and in length of their Chaſes about 18 ſuch Dyametres.

The third ſort is the *Demy Canon*, which is about 6 inches, and ½ in Dyametre of Bore, and their ordinary fortifications for each of theſe are ⅞ of dyametre thicke in Mettall at the Chamber, and ⅘ at the Trunnions, and ⅔ at the Coroniſh, and ½ at the Mouth. But of late ſome Founders haue giuen vnto the *Demy Canons* the full thicknes of one whole dyametre in Mettall at their Chambers; allowing for euery one pound weight of their ſhot ſome 220 or 143 pound of Mettall (for the biggeſt of this kinde) and more, others in proportion for the leaſt.

Theſe

These three are onely vsed in Batteries against strong Walles and defences of the Enemies, because their greater weight of shot doth shake more thē the lighter can, namely more then the demy Culuering, (although the same shooteth and pierceth further) as by experience is daily seene. But forreigne *Canons* were formerly, and are in some places, as we haue already said, named according to the weight of their shot, being of 20, 30, 40, 50, 60, 70, 80 90, 100 and 120 pound, and most of them 18 times the dyametre of their Bores in length of their Chases.

Chap. XII.

Of Culuerings, or the second Kinde of Ordnance, with their seuerall sorts.

THe second kind of Ordnance are the *Culuerings*, of which are fiue sorts, the *Saker*, *Faulcon*, *Falconet*, *Rabinet* and *Base*, wherein the Moderne founded *Culuerings*, *Sakers*, &c. doe much differ also from the Ancient, and our moderne English also from the former forreigne Ordnance, especially in Length, Bore, and Fortification, for that in former forreigne Foundings, they did as we said before cast the *Culuerings* to shoote iron shot of 14, 20, 30, 40, 50, 60, 70, 80, 100, and 120 lb. waight and called them *Culuerings* of so much as their iron shot was in waight, and they then allowed them not aboue 150 pound weight of *Mettall* for each pound weight of their shot, and allowed them also to be but between 24 & 32 dyametres of their shot in the length of their Chases, with one dyametre of thicknes of Mettall (at the most) in their Chambers or Columes of fire, each Culuering being now 30 or 32 dyametres of their Bore in the length of their Chases.

But of late (as I before said) they allow Falcons and Falconets to bee 36 or 40 dyametres of their bores in length, & $1\frac{1}{4}$ or $1\frac{1}{2}$ of mettal at their Chambers, with 250 pound, 300 pound, and sometimes more of mettall for each pound their proper shot doth weigh. The sorts of this kind by reason of their greater lengths of more dyametres shoot further & pierce deeper then those of the first kind, being loaded with as much powder as can be burnt in them whilst the shot remaineth within the Cillinder of the Peece, but being loaded with lesse, it abateth her vtmost execution, if with more it increaseth their danger of breaking the Peece, and some of the powder will goe then out vnfired, or it being fired out of her Chases, &c. little or nothing doth further the course or way of the shot. Wherefore the proportionall length fitted to their calibres, and the conuenient charge of powder in respect thereof, and of the weight of the shot mentioned in the *Theoremes* of my first part of the *Art of Artillery* will most aduance the shot with all aduantage possible. And for their vses they differ much, notwithstanding that they be reckoned as of one same Kinde, for the Greater sorts: namely,

Culuerings and *Demy Culuerings* ſerue to pierce & cut out in batteries what the *Cannons* haue ſhaken and looſed: the Sakers and Falcons ſerue for Flankers, the other ſmaller ſorts of this kind, for Field Peeces for the aſſaults, and to ſhoote at Troopes or Companies of men that are neere together. Al theſe ſhoote iron ſhot, but may ſhoote ſtone ſhot where the marks are but tender, and ſo they will ſaue much in Ammonition, and yet performe as good ſeruice as with the iron ſhot they can doe.

Alexander Bianco in his Booke intituled *Cerona e pa'ma millitare de Artiglieria* ſayth, That their Founders in *Italy* as I conceiue, becauſe their Culuerings ſhoote ſhot of equall dyametre with their greateſt Canons, & therefore would, if theſe great *Culuerings* were not vnweldie, ſhoote further, pierce deeper, and ſhake and vnlooſe more then their Cannon: for the reaſons aforeſaid they haue of late yeeres caſt fewer Canons (and more *Culuerings*) then heretofore, commending their force and ſeruice farre beyond the Canons.

But *Diego Vffano* Captaine of the *Artillerie* in the Caſtle of *Antwerpe*, for reaſons in his *Traicte de Artillerie* ſhewed, denyeth the Culuerings to be of equall worthineſſe with the Cannons: which difference groweth by reaſon that now Batteryes are made at ſhorter diſtances then heretofore: namely, within the Canons right Range, as at 80, 90, or 100 paces, ſo their opinions (both being iudicious Gunners) I conceiue to grow from the alterations alſo of Foundings, according to the Imperiall orders before mentioned, which in theſe parts of *Italy* were not knowne as it ſeemeth by *Bianco* Chiefe Gunner of *Cremes*, in the yeare 1603, nor altered from the aforenamed forreigne Foundings; whereby wee may conceiue that their ſeeming differences may be eaſily moderated by the iudicious Reader. Now for the *Harquebuſe a Crocke*, being in theſe dayes ſeldome vſed but at Sea, where eſpecially, with an Arrow, it is a very galling and ſeruiceable Peece, and may ſafely bee diſcharged 300 times in one day, or 25 times in an houre: his leaden ſhot weigheth but three ounces, and it is charged with two ounces of Powder, and by reaſon of the length thereof, might be alſo accompted of this kind, but that it is a Hand-gunne, and ſo appertaineth not properly to this diſcourſe.

CHAP.

CHAP. XIII.

Of the Cannon Periors and Perieraes, the third kind and their sorts.

OF this 3 kind are those Ordnance that shoote no Iron or Leaden shot, but only lighter, as Stone, Murthering, or Fire shot: of them there are foure especiall seuerall sorts. The *Canon Perier* being the principall, and therfore as the *Canon* of Batterie and *Culuering* bring the rest to be of their kinds, so for the same reason also may the *Canon Perier* doe the like for hers. The *Canon Perier* then, for the outside is not much vnlike vnto the *Canon* of Batterie, but that they are more vncertaine in the heights of their Calibers or Bores, some being higher and some lower in dyametre, It is a comely and a seruiceable Peece) and for those vses, namely to shoote Stone shot, they are well & sufficiently fortified; so that being duly loaden, the Gunner may therwith safely serue to defend a Breach, keep a passage, murther, and spoyle the Enemy being approached neere hand. Most foreigne *Canon Periors* are Chambred, being eyther taper or belbored in their Chambers, the Mouth of which Chamber being but eyther $\frac{3}{4}$ or $\frac{1}{2}$ in Calibre of the height or Calibre of the Mouth of the Chase, of the Peece; the difference of which at the Mouth of the Chamber is called the *Orlee* or *Rellish*, their Chambers are to be in length 4 Dyametres of the Mouth of the said Chamber. But the most of our English *Cannon Periors* are equall bored through the length of their whole Chases (which I conceiue were better to be onely taper bored in their Chamber) so as that the Mouth of their Chambers be equall in height with all the rest of her Calibre or Bore forward, towards her Mouth, because it will be thereby the better fortified in the Chamber, and so the more able to resist the force of her due loading in powder: these Peeces are to shoote the $\frac{1}{3}$ of the waight of their Stone shot in corne powder, onely abating proportionally 5 pound of powder for euery 100 pound waight of shot. The Chambred *Canon Periors* with Relishes (as aforesaid) are troublesome to load, for that they are therefore to vse a *Scafetta*, and a Rowling Rammerhead, with a shiuer in the Staffe.

The length of these *Canon Periors* are about 8 Calibres of their Bore at the Mouth of the Chase: they are to be in their Chambers $\frac{3}{4}$ in thicknes of Mettall at their Touch-holes.

The *Perieraes* are the next sort of this third kind, which are in all things like vnto the *Canon Perier* (already mentioned) but that they are much poorer and weaker fortified with Mettall, being allowed for the *Canon Perier*, 80 pound of Mettall for euery pound waighe of their Stone shot, and but 60 pound for the *Petrieraes*, whose Chamber being but $\frac{1}{2}$ in Bore of the Calibre at the Mouth, must be loaded with but $\frac{1}{4}$ of Corne powder, but if it bee $\frac{1}{3}$ then with $\frac{1}{4}$ of the Stone shot waight.

The third sort of Ordnance of this third kind being the *Port Peeces*, and

Stocke Fowlers which are Braſſe caſt Peeces open at both ends, inuented to be loaded with Chambers at the Breech end, fitted cloſe thereinto with a ſhouldring, euen as the wooden Trees for water pypes haue tapred ends to let them cloſe one into another; The ſhot and wadde being firſt put into the Chaſe, then is the Chamber to bee firmely wedged into the Tayle of the Chaſe and Carriage. Now in ſtead of round Trunnions, there are 4 ſquare tennants caſt ioyning with the ſide of the Chaſe of the Peece, on eyther ſide two, which being let into the Block or Carriage, holdeth the whole Chaſe faſt therein, leauing the Corniſh lying vpon the ledge of the Ships Port, or vpon the *Pawmure* in a Fort, and tryced vp with a rope faſtned about the muzzle; The Tayle of the *Carriage* is to reſt, and to be ſhored vp with an vpright poſt or foote, full of holes to ſlide vp and downe in a ſquare Mortice fitted thereunto, hauing a ſhiuer at the lower end thereof, with two Treſſle legges morteized before vnder the blocke of the Carriage, the foote with holes hath a pinne to ſtay the Peece vpon any Mounture aſſigned. The fourth ſort of this 3 kind are the Slings and Portingale Baſes which haue Chambers fitted into their Breeches as the Stocke-Fowlers haue, but that the Tayles that ſtayes their Chambers to wedge them faſt (as in one continued Peece of yron whereof they are vſually welded and wrought) vnto the Tayle whereof there is a long ſterne handle of iron to direct them to reſpect the aſſigned marke: They ſtand vpon a forked Prop or Pintle vpon the ends of which the Trunnions reſteth, they are loaded with their Chambers as the Stocke-Fowlers are: theſe ſhoote eyther Baſe and Burre, Musket or any other kind of Murthering Shot, being put vp in bagges or Lanthornes fitted to their Calibres. And being diſcharged, their Chambers are to bee taken out and fil'd againe, and others to be put in ready charged in the place thereof. Theſe Peeces are vſually loaded with $\frac{1}{2}$ or $\frac{1}{3}$ of the weight of their ſhot in corne powder. *Port Peeces* and *Fowlers* are vſually made of Caſt Braſſe, but *Portingall Baſes*, *Slyngs*, and *Murtherers*, are commonly of wrought iron; the lengths of the Portingale Baſe is about 30 times her Calibre; the Sling about 12 times, the Murtherers, Port Peeces, and Fowlers 8 at the moſt beſides their Chambers, their Chambers about 3 times their Calibre in length, and weigh the 6 or 8 part of the whole Chaſe.

A Table concerning Chamber Peeces.

	Length	*Heighth*	*Powder*	*Stoneſhot*	*& waigheth*	
A Chamber	12 inches & $\frac{1}{2}$	4 inches & $\frac{1}{2}$	7 lb.	6 $\frac{1}{2}$ inches.	13 lb.	*ſtone.*
	22 inches & $\frac{1}{2}$	4 inches $\frac{1}{2}$	7 lb.	6 inches.	10 lb.	
	24 inches	4 inches $\frac{1}{2}$	9 lb.	7 inches	17 lb.	
	17 inches & $\frac{1}{2}$	3 inches $\frac{1}{4}$	5 lb.	5 inches.	9 lb.	
A Slingch.	22 inches	2 inches & $\frac{1}{2}$	3 $\frac{1}{2}$ lb.	2 inches $\frac{1}{4}$	2 lb. $\frac{1}{2}$ iron.	
A Port ch.	16 inches	3 inches $\frac{1}{2}$	3 . lb.	5 inches $\frac{1}{4}$	9 lb. ſtone.	
A Baſe ch.	9 inches $\frac{1}{2}$	1 inch $\frac{1}{2}$	$\frac{1}{4}$ lb.	1 inch $\frac{1}{2}$	6 oz. iron.	

CHAP.

Chap. XIIII.

Of the fourth Kind of Ordnance, Short Gunnes, Mortars, and Square Murtherers, Pettards and Tortles, and the ſorts thereof.

Morter Peeces, Square *Murtherers*, *Tortles*, and *Pettards* are the ſorts of the fourth kind of Ordnance, and doe much differ from the former 3 kinds, and in many things alſo one of them from the other, as may appeare by the ſeuerall diſcourſes vpon their deſcriptions and vſes. The *Morter Peeces* are of ſeuerall grandures and faſhions, for ſome of them are made to ſhoote a Stone ſhot of 350 pound waight, and ſome again are ſo ſmall that their ſhot waigheth not aboue 4, 5, or 6 pound, and may be of any quantity betweene. And ſome are of one Cillinder without ſyde, others are of two, one of them leſſened without as farre as their Chamber reacheth but all of them are Chambred, or as ſome Gunne-Founders tearme it *Cambred* taperingly, being at the Mouth of the Chamber about the Calibre of ⅓ the Dyametre of the Mouth of the Peece, and in length ⅓ thereof or more as the Chaſe is longer.

Theſe *Morter Peeces* are of great efficacy, aſwell for the Aſſaylants as the Beſiedged or Defendants: for being duely vſed, they much terrifie & trouble the Enemy beſieged in a Towne, City or Fort; eſpecially by ſending vpon them Granadoes either ſingle or double, or great iron ſtone or leaden ſhot, and from within when the Enemy ſhould worke, or would reſt in their Tents and Lodgings, whereunto by reaſon of ſome Hill, building, or Wall, they are ſo hidden that none other Ordnance can bee bended againſt them; for that all other Gunnes relye principally to conuey their ſhot in a right line, to doe effectuall ſeruice, whereas this ſort worketh altogether in oblique or crooked lines vnleſſe the Peece be mounted to 90 degrees, mounting them commonly aboue 45 degrees: namely to 60, 70, 80, and ſometimes more or leſſe, accordingly as the nature of the ſeruice requireth. But for the Defendants, theſe are ordinarily vſed to ſhoote forth Fire Bals into the Champion in the night, that they within may ſee what the Enemy worketh abroad; or els when the Enemy is approached vnto the foote of the Wall, to vndermine or pierce it, or to enter a Breach already made, & cannot be well repulſed by other meanes or cannot be offended from aloft, ſhooting out of a Morter or other Perior, Bals of ſtone, old iro̅, or any other murthring ſhot or granadoes and Fire-workes. Some of them haue their Trunnions in the midſt, other more aft, and ſome euen with their Breeches being fortified with mettall about ⅓ of the height of the Mouth of the Chamber at the Touch-hole, and ⅓ of that Calibre at the Mouth of the Peece; They are of ſeuerall lengths in Chaſe, for ſome are two, and others are three Dyametres of their Mouthes Bore in length. They may bee loaded either with Cartouches

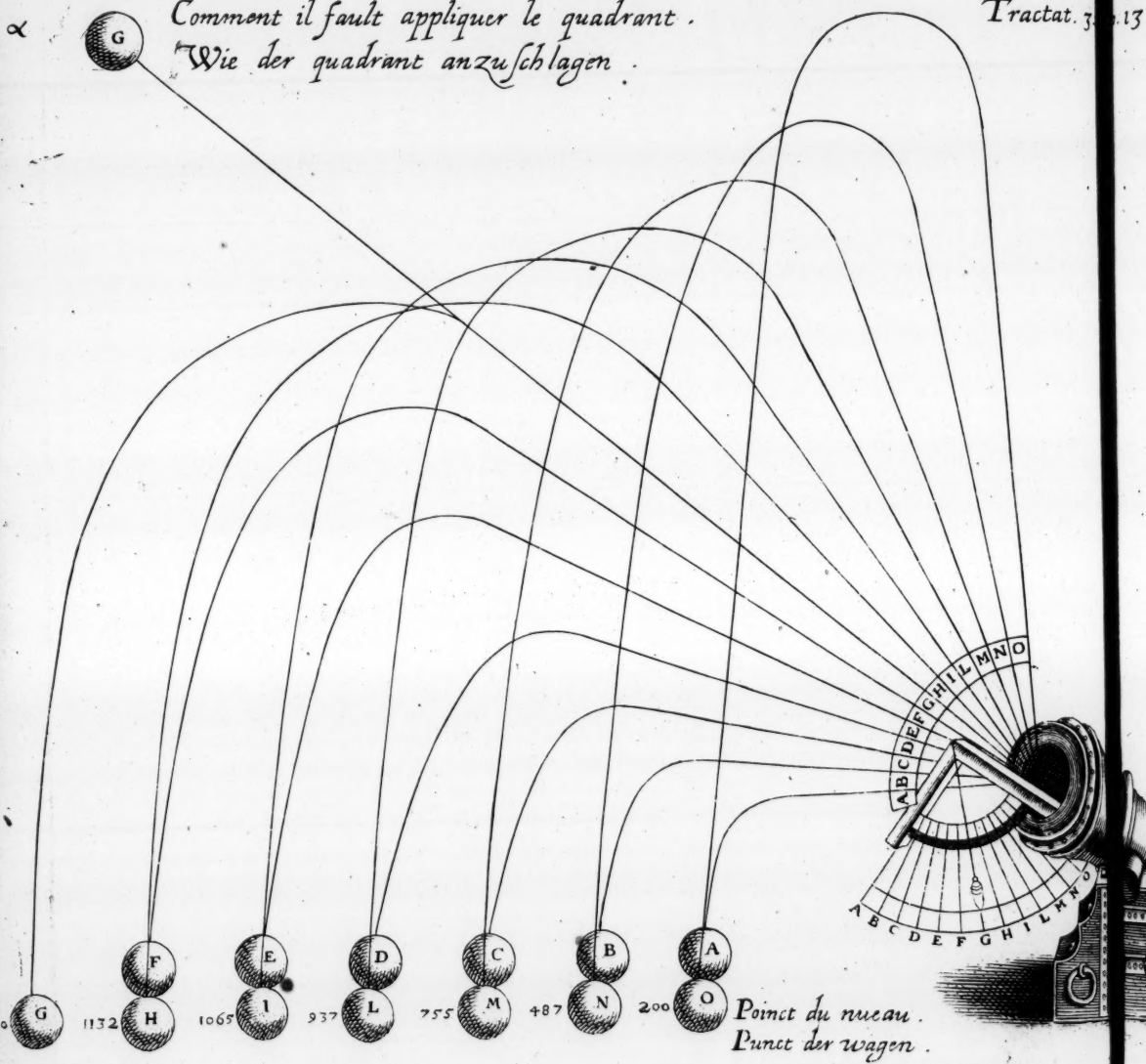
touches or with looſe powder, allowing $\frac{1}{10}$ part of the weight of the Shot, ſhooting vpon any mountare aboue 40 degrees, but with $\frac{1}{8}$ ſhooting leuell or downewards, alwayes putting home a good wadde betweene the Powder and Shot vnleſſe it be a Fire-ball, which the Powder in the Peece is to fire in her diſcharge; for then the Fire-worke muſt lye in the looſe powder, and haue a wadd before it, and ſome vſe for euery hundred the Shot weigheth proportionally to abate 5, which *Alexander Bianco* liketh not: The proportion for loading them muſt be ordered according to the ſtrength of the Peece and Powder, and waight of the Shot, and is alſo accordingly as the Mounture and diſtance is more or leſſe, if the Shot bee a *Granado* made of Potters earth baked, or of *Glaſſe*, the $\frac{1}{20}$ part of their weight will be ſufficient powder to blow them out with little or no danger of breaking: for if they ſhould haue ſo much powder as that the Ball is forced to breake within the Peece; or if any pinne-hole or vent ſhould chance to be in a mettailine *Granado*, ſo as that the powder within it be fired; the Peece would not onely breake and teare the carriage, but alſo endanger him that giueth fire, and fruſtrate the ſeruice: As was prooued by M. *Kenuins* indiſcreete practiſe in his late Maieſties *Morter Peece*, breaking it, and alſo thereby indangering the ſpectators; wherfore if the *Granado* be of caſt mettall, it were beſt to be couered ouer with the ordinary coating, to ſtop ſuch vents as is hereafter mentioned: Then will $\frac{1}{10}$ part of the weight of the Shot in corne powder be ſufficient. But if it bee loaded with a ſolide Stone ſhot, then $\frac{1}{8}$ or $\frac{1}{7}$ rather of the weight thereof in corne powder may be allowed, the more powder, the leſſe mounted, as we haue already ſaid.

Now hauing ſhewed the proportion of powder, fitting each ſort of Shot and Mounture, it will not be amiſſe to ſhew how to order and mannage the ſame Morter-peece, Gunner-like.

Firſt then the Chamber is to bee well ſponged and cleanſed before the putting in of the powder, whether you loade it with looſe powder or Cartouch turning the Mouth neere vpright; the powder being ſo put into the Chāber, ther muſt be a wad put in either of hay or Okam, & after a Tampkin of Willow or other ſoft Wood; ſuch as may, together with the powder that was firſt put in, fully fill vp the whole Chamber thereof, that there may bee no vacuity betweene the powder and wadd, or wadd and ſhot; after which the ſhot ſhall be alſo put in at the Mouth with a wadd after it; eſpecially if the Peece be not much mounted, leaſt the ſhot goe out too ſoone, and the wadd between the Tampkin and the Shot, is not onely to ſaue the ſhot from the Tampkins breaking of it, but alſo to auoide vacuities, which are very dangerous for the Peece by ſecond expanſions.

Hauing then reſolued vpon the premiſſes concerning the Peece, Shot, & Powder, as before is ſhewed, and vpon the diſtance and Mounture for the Marke, as hereafter the Rules and Tables following ſhall direct; then for the bending and diſpoſing it to the aſſigned ſeruice: Obſerue firſt to lay a ſtraight Ruler vpon the mouth of the Peece, and vpon it place a Quadrant or other Inſtrument croſſe-wiſe to ſet the Peece vpright to auoide wide ſhooting, and then placing them fore-right to eleuate it into the reſolued degree of Monuture to auoyde ſhort or ouetſhooting accordingly, as the Tables and examples following will leade you: for hauing made one ſhot, you may thereby

Comment il fault appliquer le quadrant.
Wie der quadrant anzuschlagen.



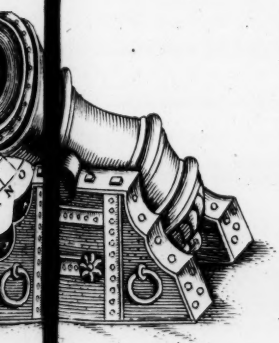
Poinct du rueau.
Punct der wagen.

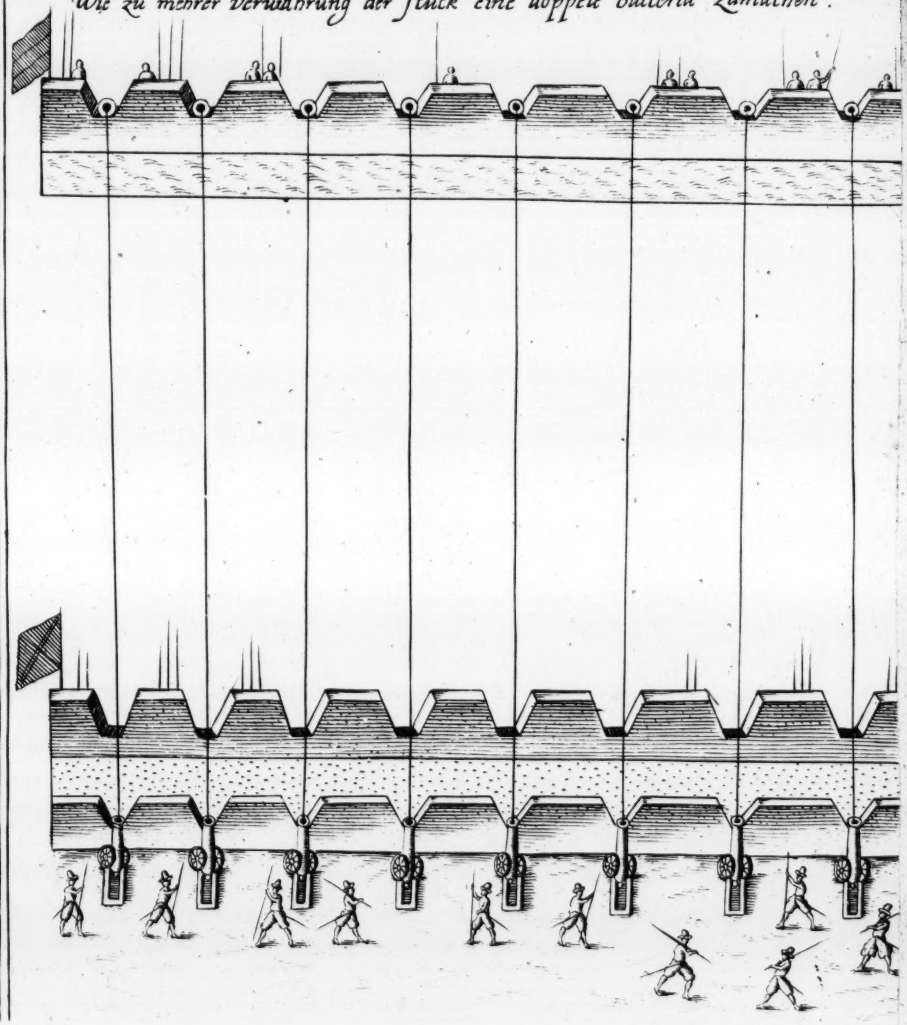
tat. 3. 13. fig. 2.

Tract. 2. dial. 13.

Comment pour plus grande aſseurance des pieces ſe fait vne double batterie

Wie zu mehrer verwahrung der ſtuck eine doppele batteria zumachen.

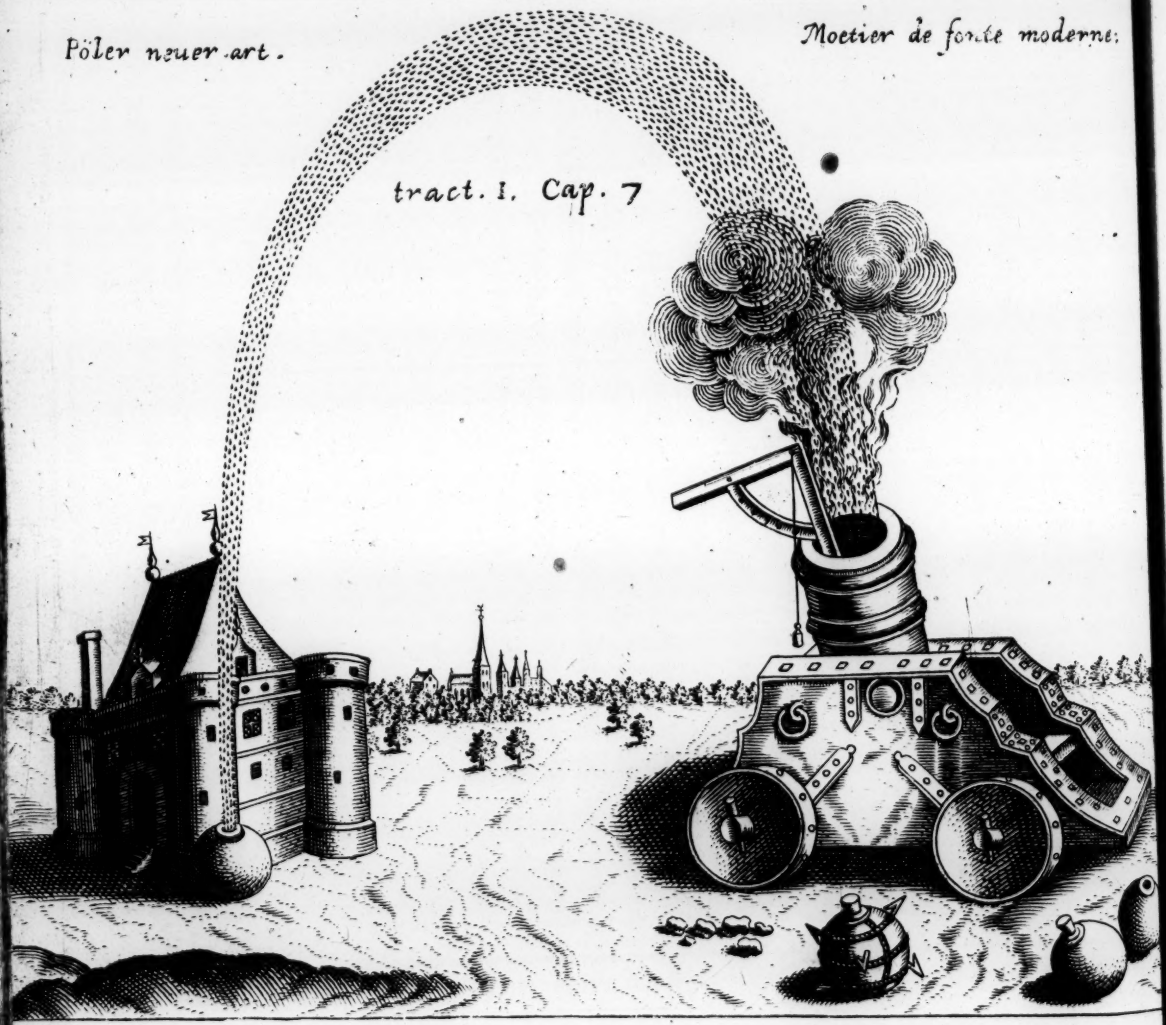




Pöler neuer art.

Moetier de fonte moderne.

tract. 1. Cap. 7



thereby proportion the reſt, conſidering whether you are to ſhoote with or againſt the wind, or whether it blowe towards the right or left hand, and whether weakely or ſtrongly; and ſo accordingly to giue or abate the aduantage or diſaduantage: which iudgement, not Rule muſt induce, and yet by helpe of the Notes following, of mine owne experience late made in one of his Maieſties Morter Peeces, and by theſe Tables, any iudicious Gunner may with a Shot or two firſt made out of the Peece hee with practiſe may very much helpe himſelfe.

Captaine Vffano *his Table for a Morter Peece to ſhoote therewith by the twelue Poynts of the Gunneers Quadrant.* And

Poynts	*Paces*
0	100
1	248
2	377
3	468
4	534
5	570
6	583
7	566
8	532
9	468
10	377
11	243
12	000

Mine owne Notes of practiſe in a Morter peece that ſhot a ſtone ſhot of 5. inches in Dyametre high. The Morter Peeces Chamber being 2½ inches at the Mouth therof, and three inches deep, and the reſt of her Chaſe being 10 inches deepe, which I diſcharged with three ounces of powder there being little wind.

degrees	*yaras*	*Skores*
At 45	750	37½
At 50	710	35½
At 55	675	33¾
At 60	620	31
At 65	575	28¾
At 70	480	24
At 75	360	18
At 80	270	13

A Table out of Vffano *for the Morter Peeces, Randons made for euery degree betweene the Leuell and* 90 *degrees.*

degr.	*paces*	*degr.*	*gr.*	*paces*	*degr.*	*degr.*	*paces*	*degr.*
0	100	89	16	392	73	31	539	58
1	122	88	17	406	72	32	543	57
2	143	87	18	419	71	33	549	56
3	164	86	19	432	70	34	552	55
4	285	85	20	445	69	35	558	54
5	104	84	21	457	68	36	562	53
6	224	83	22	468	67	37	568	52
7	243	82	23	479	66	38	573	51
8	262	81	24	490	65	39	477	50
9	280	80	25	500	64	40	580	49
10	297	79	26	510	63	41	582	48
11	314	78	27	518	62	42	583	47
12	331	77	28	524	61	43	584	} 46
13	347	76	29	529	60	44	582	
14	363	75	30	534	59	45	582	
15	377	74						

The vſe of the former Table.

The vſe of the Table may bee thus explained. Hauing once made knowne the diſtance the Peece did ſhoote at any Monuture giuen. As for example: ſuppoſe at 53 degrees which conueyed the ſhot 700 paces, and you deſire to know how far ſhe would ſhoote at 60 degrees. Now becauſe 700 degrees is not at all in this Table, but againſt 60 degrees there ſtandeth 529 paces. Therefore ſay by the Rule of 3, if 562 the number againſt 53 degrees giueth 700 paces, what ſhall 529 the number againſt 60 degrees giue, multiplying 700 by 529, and diuide the product by 562, and the Quotient will be 649 ½ fere, the number of paces which the ſaid Morter Peece will ſhoote at 60 degrees Monuture being alike loaded, and hauing ſuch like accidents as it had when it was ſhot off at 52 degrees, and ſo for any other number of paces or degrees, or diſtances aſſigned.

The ſecond ſort of this fourth and laſt kind of Ordnance, are the *Pettards*, which are ſhort Peeces of late yeares deuiſed and practiſed to make ouertures into Townes, Cities and Forts by breaking open their Ports & Gates, and blowing vp of Bridges and Walls by meanes of the force of powder fired. Of theſe there are of ſeuerall formes and magnitudes, euen as they are of ſeuerall vſes and for different ſeruices; eſpecially in greatnes when great force is requiſite. Some of them are caſt in ſhape not much vnlike the faſhion of a Grocers or Apothecaryes ſpice Morter, and ſome are tapered much like a Coopers water payle, little deeper then the Dyametre of their mouthes but being not aboue ⅛ in Dyametre at their bottome or breech of their mouthes Calibre, and in thicknes of mettall ⅛ of the Dyametre at their breech, and leſſening in thicknes towards their mouths. Their magnitudes are ſome to hold but one pound of powder or leſſe, and others to hold 50 lb. or more, and they vſually allow 4 lb. of Braſſe, or 5 lb. of iron to caſt a *Pet.* for one pound of powder, and 250 pound of Braſſe, or 300 pound for a *Pettard* that ſhall hold 50 pound of powder, vſing thoſe proportions diminiſhed for leſſer, and augmented for greater. The *Pettard* is ſometimes to be vſed in places acceſſible and inacceſſible, Suppoſe then we are to *Pettard* a *Port* or *Gate* vnto which we may approach, in that caſe a skrewed hooke is to bee let into the Port, vpon which the *Pettard* with her *Planchier* or *Matria* is to be hanged, as in the 13 figure at *e* is repreſentd.

The *Plãchier* is at leaſt to be 3 inches thick, arm'd with irõ plates to defend it from ſplitting, it is alſo to be vnderpropped with the forked Reſt, & ſtayed in the ground at the hinder end to hinder the reuerſe thereof. *Pettards* are to be loaded with fine corne powder, the finer corned the better being very hard beaten in, by little and little at once with iron drifts or ſuch like, of the iuſt height of the Dyametre of each places concaue of the *Pettard*, vntill it be full within one finger breadth of the top, and then ſome vſe to make a hole through the powder vnto the bottome with a pyke head or ſuch like, into which hollownes they put in certaine quils filled with raw quicke-ſiluer. Laſtly, they couer the mouth thereof with a waxed cloath, being cut of the iuſt breadth of the inſide of the mouth of it, & fill vp alſo the reſt that is yet empty with molten waxe, mingled with hempe cut, or with toe rather. They

are

are to haue a ſocket and backſtay for the vnderproppe, and a pype ouer the Touch-hole which muſt be filled with ſlow and ſure receipt of Fireworke, to the end that the *Pettardier* hauing by a pryming of quicke powder giuen fire thereunto, and retired for his ſafety, wherin he muſt be carefull to auoid retyring in the right line of her reuerſe, for feare of danger.

But if we be to *Pettard* a *Port* vnto which wee cannot approach to hang the *Pettard* thereon, then make a little woodden horſe with 4 wheeles or Trucks lyned with Cloath or Wooll to auoide making noyſe, the Handle whereof is to carry the ſaid *Pettard*, being at the leaſt 40 foote long, with a Counterpoyze at the other end, hauing the *Planchier* faſtned cloſe before the mouth of the *Pettard*, with the crochet or vnderprop to place the ſame as cloſe and flat againſt the *Port* as is poſſible, and the aftmoſt end of the ſtaffe or prop made firme againſt ſome ſtake in the ground (to ſtay the reuerſe) ſo alwaies that it belong enough to reach ouer the dike or drawbridge to be driuen cloſe, that the *Pettard* may be firmed againſt the Gate. Then ſo loded and fire giuen to the ſlow vent or pype with the ſlow receipt, the retrait may haue time to be oblikely made, leaſt her reuerſe ſupprize the *Pettardier* before he can get out of the danger therof. The figures and diſcourſe following as well for the acceſſible as for the inacceſſible Ports here annexed, will make that which we haue ſaid the better vnderſtood.

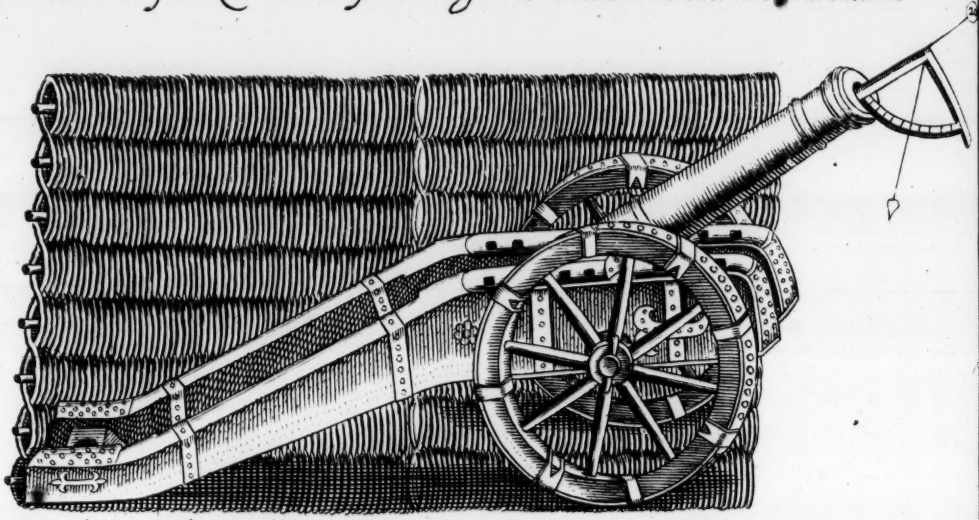
CHAP. XV.

Of ſeuerall wayes to preuent the effectuall working of Petards.

DIuers and ſeuerall meanes there are alſo to preuent the placing and effectuall working of the ſaid *Pettards*: whereof a word or two in briefe. The firſt is by a kind of ſtrong iron Gridiron or Grate ſo placed before the Port, ſomewhat diſtant, as 3 or 4 feete off, that the *Planchier* of the *Pettard* cannot come cloſe enough to the Gate: for that the Ayre betweene it and the *Pettard* will doubtleſſe make the action therof to be of little or no effect: otherwiſe to ſpoyle the *Pettardier* and Aſſiſtants neere, a fall-trap being let go with a buckle tricker when the *Pettardier* ſhall either tread vpon a draw-bridge or bord couered with earth, which will pull out the buckle, and ſo it will let a great circle with iron works by a ſpring fall violently vpon his head; likewiſe they impeach the hanging and propping *Pettards* by certaine points of iron about 3 feete long placed vnder the Draw-bridge, which when it is drawne vp, ſtands out and impeacheth the placing of them againſt it. In like ſort by a trap-draw-bridge which will fall downe as ſoone as the *Pettardier* ſhall tread thereon, and ſlide him and his *Pettard* into the dyke; ſo alſo if a paire of compaſſes of iron with teeth on the legges haue their head with a ioynt faſtened aboue to the ſtone-worke of the *Port*, ſo that as ſoone as the bridge or bord which holds the compaſſes and teeth open, is vnlooſed by treading thereon, they are forced together by ſtrong ſprings moſt violently, which terribly will claſpe and teare him in moſt miſerable manner. Another is by two ſemicircles with ſawteeth to claſpe together as ſoone as the *Pettardier* ſets foote on the falſe bord or bridge to vnhitch the ſpringholds. Alſo a cord being faſtned to the outmoſt end of the looſe bridge, which by the *Pettardiers* ſtepping theron, vnlooſeth the hold, ſo a number of ſtones will thereby all fall on his head, and beate out his braines. So alſo a falſe Port with 3 or 4 feet or more of vacuitie betweene it and the true Port, riſing higher then the true Port in groues hoiſted vp as a Percullis, and ſhall fall when the *Pettardier* ſteppeth on the falſe bridge; likewiſe by a falſe or looſe bridge which ſhall pull a tricker that ſhall let downe a ſnaphance, and giue fire vnto 20 or 30 loaded muskets, whoſe mouthes ſhall be ſeene through the Port, and diſcharge themſelues vpon the *Pettardier* and his aſſiſtants, As the figures in the 6, 7, 8, 9, 10, 11, 12, and 13 Chapters of the ſecond book intituled *Recuil de plusieurs Machines millitaires* will more manifeſt vnto the eye.

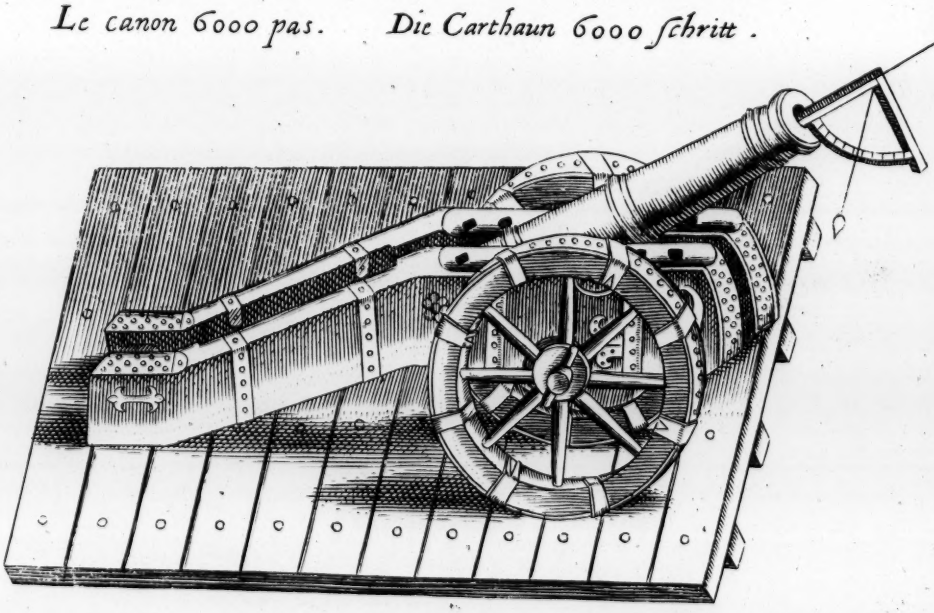
CHAP.

Quelle ſera de plus grande portee la Colubrine ou le Canon.
Welches ſtuck am weiteſten trägt die Colubrina oder die Carthaunē



En tel poinct la Colubrine portera 7000 pas. quelq̄ peu plus ou moins.
In ſolcher erhöhung trägt die Colubrina vngefehrlich 7000 ſchritt.

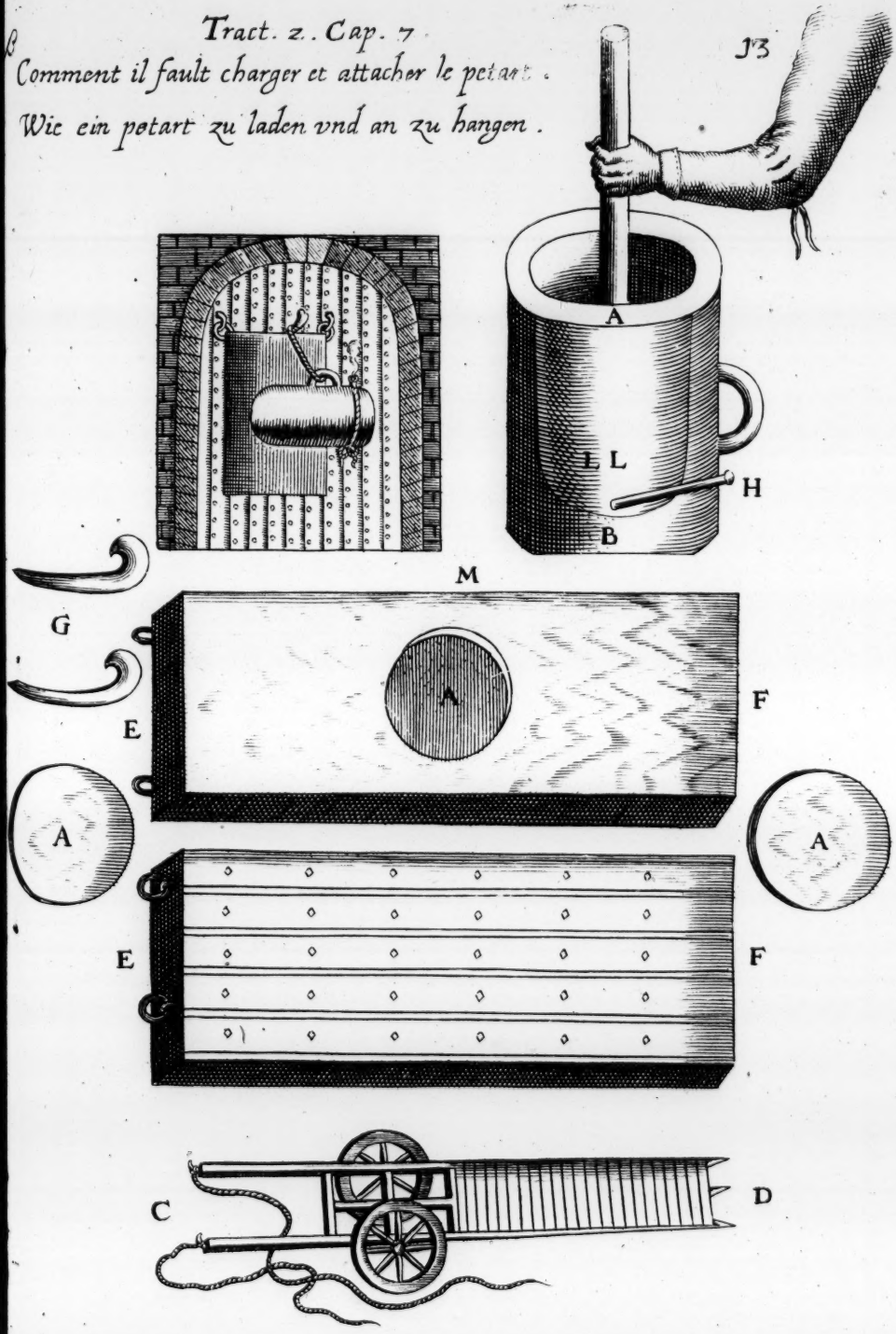
Le canon 6000 pas. *Die Carthaun 6000 ſchritt.*



Tract. 2. Cap. 7.

Comment il fault charger et attacher le petart.

Wie ein petart zu laden vnd an zu hangen.



Chap. XVI.

How and with what inſtruments you may breake the Pyles Paleſadoes, Grates, Perculliſes, and Chaynes, or ſuch like iron or wood-worke to lay them open for entry.

TO breake *Paliſadoes, Grates, Barres*, and ſuch like encloſures of any Towne, Caſtle, Fort, or ſtrong houſe. The inſtrument that is noted with A, which is a wrench that being aplyed and faſtned as the figure ſheweth, wil teare open ſtrong Bars, Or the Saw B, in ſawing aſunder the ioynts, Or the Crow C, whoſe Clouen foot being gotten betweene the *Ioynts*, will forcibly diſioynt them, Or els Axlike wedge D. But if the enterprize bee to be ſecretly executed without noyſe of ſtrokes of tooles, then a fire wheele in ſuch manner faſtned, prymed and fired, and fixed as the figure ſheweth, wil ſone make way, if it be wel ordered, for the purpoſe, as hereafter in this *Chapter* ſhall be directed. The ſame inſtruments are to be applyed vnto *Barres* of Gates, of Townes and Caſtles, if they may be approached ſecretly. For elſe there can bee no better way to make ouerture then by battery with great Ordnance, which from far will ſoone make a breach aſwell in Ports which are vſually fortified with barracadoes and other defences, but may be therby ſoon battered to make ſufficient breach to enter by, yea were it in bulwarks or Curtins as hereafter ſhall bee ſhewed more at large. If you would force a great Port of a Towne ſecretly, there is another meanes beſides the *Pettard* already ſpoken of, namely the Skrew Nut marked E, and his skrew-barre A, with which in turning the winlaſe X, it will ſoone breake open the Port ſo that the backeſtay be faſt and ſtrong enough. Now if it be ſtrengthned with chaines of iron within, although they were great and ſtrong, yet by the skrew ſpindles 4 and 5, turning the Nut B, by the winlaſe & ſpykes thereof, and ſo in like manner the iron *Bars* and *Grates* may be broken aſunder or pulled out with the *Pinchers* C, and the drawing hammer D, and the mallet of hard-wood I, and the ſhort Axe-wedge 2, Next to thoſe inſtruments the drift bridge betweene them repreſented was inuented to reach ouer a dyke and to put any Towne or Fort to the Scalado, it is not much vnlike the Cart-bridge vſed for the *Pettard*, as before may be ſeene in his *Chapter*, but that it is not ſo great and heauy as it.

CHAP. XVII.

How to Diſpart any Peece of Ordnance that is truely and equall bored in the middeſt of the Mettall thereof.

OF all things belonging vnto a Gunner, the chiefeſt is to bring the Mettal of his Peece euen; which the Gunners call diſparting: wherefore the diſpart for any Peece of Ordnance, whoſe concaue Cillinder or Bore lyeth equall and truely in the midſt of her Mettal, is nothing els but to equall the difference betweene the thicknes of the mettal that the Baſe Ring hath in Semidiametre more then the ſemidyametre at the Muzzle Ring, without which equall difference applyed vpon the vpmoſt of the mettalls on the Muxzle Ring eyther had (or gueſſed at with diſcretion,) it is impoſsible to direct a Peece to any marke, to make a ſhot to an aſſured good effect: The diſpart is many wayes to bee found. Firſt in ſuch Peeces as are not Chambred by a priming iron, pur downe to the lower part of the Bore in at the Touch-hole, and making a marke vpon it euen in height with the higheſt of the mettall vpon the Baſe Ring, then carrying the ſame meaſure vnto the Mouth, and placing it vpright with the lower end of the priming iron iuſt on the lower part of the Bore there; Then looke how much the mark, ſo made on the pryming iron, reacheth higher then the vpper part of the mettall of the Muzzle Ring, ſo much is the length of the diſpart to bee placed vpon the higheſt of the mettall there: Or els taking the Dyametres of the Baſe Ring, and alſo of the Muzzle Ring with a paire of Caliber compaſses, or by guyrding or otherwiſe, and the halfe of their Dyametres is the true length of the diſpart to be placed vpon the higheſt of the mettall on the Muzzle Ring as is aforeſaid.

As for example, ſuppoſe the Dyametre of the Baſe Ring to be 24 inches, and the Dyametre of the Muzzle Ring to be 18 inches, the difference is 6 inches, the halfe whereof 3 inches, is the length of the diſpart ſought. Or take the compaſse in inches & parts at the Baſering, and diuide it into 3 equal parts,, and doe the like at the Muzzle-ring. And the halfe of their difference will be the diſpart for any Peece that is truely bored. Or rather hauing guirded the Peece at the Baſe and Muzzle ring, looke how many times 22 quarter of inches are therein contained, ſo many times 7 quarters of inches doth the Dyametres containe. And the halfe of the difference of thoſe two Dyametres is the due diſpart ſought. Or els take a Rule or ſtaffe, and lay it croſſe vpon the Baſering of the Peece, and then take a lyne and plummet, and hold it that it may hang cloſe: firſt to the one ſide of the Peece, and then to the other ſide thereof, marking alſo vpon the Rule or ſtaffe, where the lyne toucheth at both times, that the ſtring onely touch the ſydes of the Peece without any bending, Then lay that Rule and Meaſure to the mouth: likewiſe looke what the ouer meaſure commeth vnto, take the halfe of that meaſure

measure for the due disparr. Now for Chamber Peeces, there can bee no certaine generall Rule giuen for their disparts: for they must be ordered according to the forme of the Chamber and orelowe or Hall of the Peece; whether it be *Sling*, *Base*, *Fowler*, or *Port Peece*. But euery discreet and vnder standing *Gunner*, when he seeth the Peece, may by what hath beene sayde, know what to doe therein: for Port Peeces, and Fowlers they onely shoote stone, and not iron shot.

Chap. XVIII.

Of certaine faults committed in Forreigne Foundings of Ordnance.

THe industrious Gunner may by that which hath beene said, take true knowledge of all sorts of Ordnance, as well Antient as Moderne, and also vnderstand the reasons, grounds, and vses of them, and of any others which shall hereafter be seruiceably inuented, and so be able to iudge of the goodnesse and defects of any Peece whatsoeuer, to make choyce of the best, and in time of neede to make vse of the worst; yet it is not imposed vpon the Gunners Office to practize Foundings of Ordnance, although it bee one of the most necessary Sciences of these times in vse, which was neuer bred among the common sort of men, as other handy-crafts were, for that they must not onely be conuersant and expert in the Mathematickes, but also trayned vp thereto from their childhood if they will be excellent for ready handines therein, which makes mee and others wonderously maruell, that so necessarie a science should bee no better respected amongst vs, and that that there is no more care taken to bring vp expert Founders of Ordnance for times to come, in this war-like age. But if we shall well examine the most vsed Foundings in *Europe*: namely, those of *Lisbon*, *Malaga*, *Barcelona*, *Naples*, *Cicillia*, *Cremes*, *Millan*, *Genoa*, *Venice*, *Mollines* and *Vtrecht*: in which by reason of their continuall practise they might easily haue become excellēt & expert, yet whether it be by negligēce ignorance, or els by the too much haste made by those that haue the charge and command of those Foundings, it is apparant that they commit great and absurd faults therein. Some of their Peeces (and not a few) are bored awry, their *Soule* not lying in toe widst of the body of Mettall; some are crooked in their Chase, other of vnequall bores, some too light towards the Breech turne their mouthes downewards in their discharge, and so endanger their owne Vawmures and Defences: insomuch that my selfe and other good Gunners in time of seruice could hardly finde means to remedy that fault, eyther by hanging waight vpon the *Pommell* or *Cascabell*, or by wedging it vnder at the fore Transom of her Carriage: others are too heauy also in their Breech, by placing the Trunnions too much aftwards, that Coynes can hardly be drawne, but by the extraordinary strength to manage and weigh them vp behind, or lay her vnder mettall without putting a long

leauer

leauer in her mouth. Some and a great many Peeces are come forth of the Furnace ſpoongy, or full of hony-combes and flawes, by reaſon that the mettall runneth not fine, or that the moulds are not throughly dryed, or well nealed: whereby eyther the Gunner that ſerueth with them is much endangered, they being as bad or worſe to ſerue with, as thoſe that are too weake and poore in mettall: for if they be loaded with ſo much powder as is ordinary for thoſe ſorts of Peeces (as may often happen when ſuch Gunners load them, as are either ignorant or negligent in examining their defects) they will either breake, ſplit, or blowingly ſpring their mettalls, and (beſides that miſchiefe they doe) they will be made vtterly vnſeruiceable euer after. Wherefore to auoyd thoſe dangers & faults, Gun-Founders may do well to conferre one with another, and alſo with vnderſtanding and experienced Gunners thereupon, who with the hazard of their liues haue often ſeene into thoſe inconueniences: yet thus much I dare ſay to the due commendations of our Engliſh *Gunnefounders*, that the Ordnance which they of late yeares haue caſt, as well for neatnes, as alſo for reaſonable beſtowing and diſpoſing of the mettall, they haue far excelled all the former or forreigne aforementioned foũders. But it is to be feared that there being ſo few of that profeſſion here imployed for Founding of Braſſe Ordnance, (only Mr. *Pitts* and his Brother, and Mr. *Philips*, and as yet ſo few or none brought vp to learne it vnder them,) as that it is like that hereafter there may bee a great want of honeſt and skilfull Gunnefounders in England, the inconuenience that els may hereafter ſo befall, I hope will bee foreſeene and preuented in good time.

Le Sieur du Praiſac in his 13 Chapter of his *Military Diſcourſes*, aduiſeth Founders to haue a ſpeciali care for the temper and Allayes of the mettalls, the inward cleannes of the moulds and nealing of them well, and to their Caps and Cauities to anoint them with cleane greaſe, and to guard and binde them well with iron, to dry them and ſettle them firmely, and for the due placing of the Trunnions, as is ſhewed in the 22 Chapter hereof, that they may ſo neerely equiballance one end with the other, that one Gunner with a Leuer or Handſpyke may rayſe or imbaſe it vpon her Cariage, eyther for the draining or putting in Coynes to direct them, or lay them vnder mettalls, The running of the mettall not fine or too cold, and the mould not well nealed, or the mettalls not well incorporated; either of theſe cauſeth flawes, crackes, ſpungynes, or hony-combs in the mettall of the Peece, whereby great danger often enſueth.

CHAP.

Chap. XIX.

Concerning the League and Alligation or mixture of Mettals to Found great Ordnance.

FOr the Natural viſcuoſity, ſoftnes, & dulnes of the colour of *Copper*, there hath for the Foundings of *Ordnance* beene many Alloyes, Leagues, or Alligations of other mettalls by ſeuerall Founders vſed as their diuers colours and tempers doe manifeſt. True it is, that the proper Alloy for Copper, is fine Corniſh Tinne, when as you would haue your worke ſubiect to the Hammer, or els it will not be reduced to ſuch ſubtilty; as to endure the fire, or to make veſſells off. But when as it ſhall be accompanyed as ſhall herein bee hereafter mentioned, it doth not onely change the name, alſo the aſpect and Nature thereof, as to bee called Ordinary Braſſe, Bell-mettall, or els Braſſe for Ordnance, Braſſe ordinarily is made onely by Tinne, Copper, and *Lapis Caliminaris*. Bell-mettall with more Tiune and ſome Latton, for Bells, Mortars, and for Ordnance, As *Biringuccio* ſayth, 12 pound of Tinne for 100 pound of Copper, for Bels 23 or 20 pound of Tinne for 100 pound of Copper to cauſe the better ſound, and accordingly as they are to be greater or leſſe, wherein I intend not here to giue any other Rule; but to mixe them by waight, and meaſure, as diſcretion and iudgement ſhall induce. But more particularly for Ordnance, I haue thought fitting to relate the opinions of ſuch worke-maſters and Authors as I haue receiued inſtructions from. *Ierome Roſſelli*, ſaith, that for 16 lb. of Copper, 10 lb. of Tinne, and 8 lb. of Latton, and that the Tinne giueth hardnes, and ſothereth the Copper and Latton, and that the Latton giueth them colour together, adding the more force to reſiſt the vehemency of the powder fired in them, ſo that they make the Peeces that are caſt of that mixture to be faire and ſtrong. *Alexander Bianco* in his *Millitarie* ſaith, that the beſt Allegations of thoſe Mettals for Ordnance, is for 100 lb. of Copper, 20 lb. of Tinne, and 5 lb. of Braſſe or Latton is to be mixed. *Diego Vffano* in his *Inſtruction de Artillerie* ſayth, that the beſt Legature for Ordnance is 100 lb. of Copper, 8 lb. of Tinne, and 5 lb. of Latton, and 10 lb. of Sow-lead, affirming that Lead be ing tough and cold, maketh it alſo become hard.

And *Sieur du Priſſac* in his Military diſcourſes ſaith, that the French Founders vnto euery 100 lb. of Copper doe either adde 20 lb. of Bell mettall, (which is 25 lb. of Tinne and Lead, for 100 lb. of Copper or Braſſe) or elſe 10 lb. of ſoft Tinne to each 100 pound of Copper.

Chap. XX.

Of the Powders or Earths to make the Moulds to caſt in Braſſe Ordnance.

FOr the Foundings of Great Ordnance, there are ſpeciall ſorts of *Earthes*, whereof the Moulds and Modells are compounded either to caſt in Braſſe or iron, whereof it behoooueth to ſeeke the beſt, namely that are able to reſiſt the fire and receiue the melted mettalls, ſo that they may render them to bee caſt and Founded neatly without being ſubiect eyther to be diminiſhed, crackt or peeled when they ſhall be nealed, which is ſuch a matter as without experience cannot be done well. The rather be cauſe that Earth in it ſelfe generally taken cannot ſafely be choſen, the colours thereof is no ſufficient ſigne: for we ſee ſome earth to be white, ſome blacke, ſome yellow, and others red; and of each ſome are good, ſome bad. But none of them can by their colours be aſſuredly ſaid or choſen for good in effect: for there may bee ſome of each of thoſe colours good; yet all earths being eyther fat or leane, or ſoft, or groſſe, or viſcuous, whereof the leane ſoone turneth vnto duſt, without holding together, which alſo are a long time drying, and are but of little continuance for ſtrength. The Fat and viſcous Earths ſhrinke and chappe, and doe ſoone breake by their naturall brittineſſe, and doe often grow crooked by the vneuennelle of their mixture or temper, whereby they become crooked in the Mould, and ſo warpe the patterne it ſelfe: ſo that it is rare that ſuch a Peece ſhould come neatly or well out of the mould: Where upon we may conclude that good *Earths* are neyther Fat nor Leane, but betweene both, and of a fine and ſubtill graine or mould, which ſoone dryeth and remaineth firme, without breaking, being able to reſiſt the vehemency of the fire; and ſuch *Earthes* are moſt commonly of a yellow or red colour: but relying not vpon the colour, prooue the quality of your *Earths* with iudgement, and ſo will experience the *Miſtriſſe* of *Art* be your beſt Tutour to direct you to the beſt powders, which muſt be the firſt foundation of your worke.

But to finde ſuch as are fit for your worke, it behoooueth you to ſinke diuers pits or caues vnder ground, which haue not beene much ſtirred. And after you haue begun your worke, and compounded your *Earthes* in a banke or heape, and wet and moyſtened them like a paſte, begin then to beat them with a rod of Iron, as the Potters vſe to doe their Claye. Then take two third parts of the whole quantity, and mixe it with lynt of Linnen cloth and then beate the ſame againe together vntill they bee well incorporated, that they may appeare all one ſubſtance, and if any ſmall ſtones ſhould chance to fall amongſt it to picke them out or bruiſe them as ſmall as may be thereby, and ſo the powders being well tempered may ſerue for your moulds and formes.

Some if they cannot haue ſuch *Earths* as they would, content themſelues, with

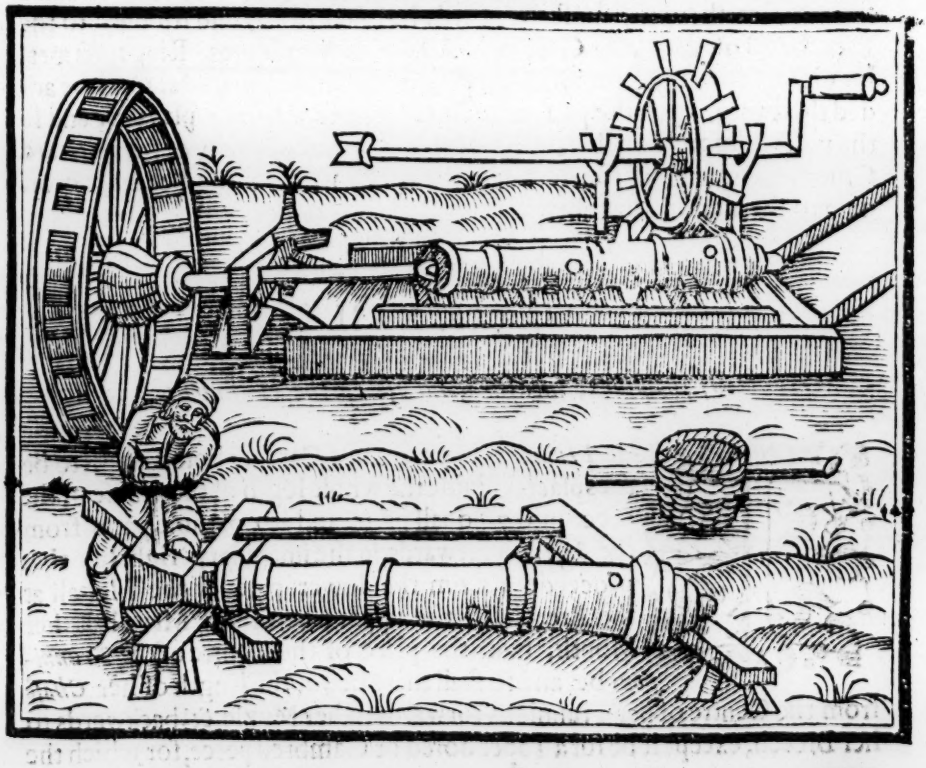
with ſuch as they can get, which when they haue tempered into paſte, they dry, and then beate and remoyſten; others mixe it with burnt ſand and aſhes; others hauing but weake *Earths*, temper them with water wherein burnt ſalt is diſſolued, mixing therwith Scales or Lymmel of iron finely beaten and ſearced.

And laſtly, ſome mixe therewith Horſe or Oxe dung, and ſome vſed ſedge and ſtraw finely chopt and mealed, each to his beſt liking, endeauouring to preuent the ill accedents that may hinder the good ſucceſſes of their workes.

CHAP. XX.

Of making of Moulds for the Founding of Ordnance.

EAch Workemaſter in any Art whatſoeuer, holdeth alwayes eyther the way wherein hee hath beene taught, or els that which in his iudgement and vnderſtanding hee thinketh to be the beſt: Euen ſo is it with Gunne-Founders, who notwithſtanding the meanes that they vſe in Foundings are diuers and many, according as they are either great or ſmall, yet almoſt all tend to ſame end.



And hauing ſo prepared and reſolued of what kind, and what ſort of that kind the Ordnance is, you intend to Caſt you are then firſt to make a Modell or perfect patterne thereof, eyther of Timber, or of Earth (or both) with all the Mouldures, Ornaments, and Compartiments, euen as you would haue the Peece to be, which you muſt thinnely anoynt with ſoft hogs greaſe, and then couer it ouer with a Colume of the aforeſaid tempered earth, made and dryed by little and little, augmenting it vntill it bee of a competent ſtrength & thicknes; This Colume muſt be to betaken into two or more parts, to the end to take the ſaid Modell or patterne out of it, and it is to be fortified on the out ſide with Plates of iron as long as the Chaſe of the Peece, and with iron wyres an inch each from other, and laſtly with iron hoopes a foote or two aſunder, to knocke off and on as occaſion ſhall require. There muſt alſo bee a ſmooth and equall Cillinder, whoſe Dyametre muſt be iuſt the height of the Bore, and made of the ſame earth moulded vpon a ſtrong Iron ſquare Barre, and vpon a cord woulded about the ſame, therewith to make the ſoule or concaue hollow Cillinder of the Peece, by placing it (by helpe of the Baſe and Muzzle-ring) exactly in the midſt of the vacuity of the outermoſt Colume, which when the Patterne or Modell ſhall bee taken out, will remaine hollow to receiue the mettall that muſt make the body of the Peece. All theſe muſt be well ioyned ted together, poliſhed ſmooth, and dryed and nealed, that the mettall berunne fine, may come off, ſmooth and neate.

Laſtly, the patterne of the Breech, with all the Mouldures, and Caſcabell is in like manner to bee couered ouer by little and little with the ſame tempered earth, which muſt afterwards be luted neatly and ſtrongly to the Breech end of the outter Colume: All which Mouldures, Rings, Armes, Deuices, Flowers, Trunnions, Dolphins and Circles may be at pleaſure added therevnto, vpon the patterne eyther in waxe, earth, or playſter, and ſo the perfect impreſſion thereof be receiued by the concauity of the outward Colume, keeping ſtill the due preſcribed proportion of the Peeces, according to the kind and ſort thereof.

Chap. XXII.

Of the place, meaſure, and vſe of the Trunnions.

THe *Trunnions* in peeces not Camber bored ought to be thus placed, diuide the whole lẽgth of the Chaſe of the peece into 7 equall parts, and at 3 of thoſe parts from the *Baſe ring* forwards, in the imaginary right line that proceedeth from the lower part of the Mettall at the Breech, to the vpper part of the Mettall at her Mouth, muſt the place of the Cenrre of the *Trunnions* be, and ſo ſhall there be ⅘ of the length of her *Chaſe* from the Centre of her Trunnions forwards to her Muzle, & ⅖ backwards to her Breech, except it be for a Taper bored or Cambred peece, for which the Trunnions

Trunnions must be placed more backwards, becauſe the thicknes of mettall to the breechwards is greater in compared proportion then it is in equall bored Peeces, which would otherwiſe become breech heauy, & ſo be troubleſome to manage, and it muſt be ſo ordered for theſe ſequent reaſons. Firſt for her better fortitude, Namely to take hold the more firmely in the Mettall of her body, and not lye directly againſt the concaue Cillinder of the Bore. Secondly, that being ſomewhat vnder it, they will the better ſupport the great waight of the mettall: and laſtly, that therby they may be onely ſo much heauier towards their Breech as may be ſufficient to keepe her ſteady in her diſcharge, and not be too vnweldy, but conueniently approaching neere equiballancing for the mounting and mannaging thereof, which the *Germane* and *Spaniſh* Founders doe ſomewhat ſeeme to helpe, by placing Dolphins ſomewhat more towards their breeches: and ſome others haue thought to remedy it by placing of ſtrong Rings in Staples of caſt mettal in ſtead and liew of theſe Dolphins. But for ſuch Peeces as haue neither Dolphins nor Rings to mount or diſmount by them, a Leauer being put into their Mouthes, and a rope faſtned at the mouth vnto the outward end therof, and vnto the Pomell or Caſcabell at the breech, they are to be thereby equibalancingly ſlinged to mount or diſmount them conueniently. The Trunnions ought next the body to be in Dyametre one Calibre of her proper bore in thicknes, and alſo one in length, onely leſſening $\frac{1}{10}$ of a Calibre, tapering by little and little towards their outward end of them. There are fiue things eſpecially to be regarded in caſting of mettall. The firſt is to make the formes and moulds duely. The ſecond that they be well nealed with Charcoales or dry wood. The third to place them well in the Pit. The fourth is to melt the mettall to runne well and fine. The fift to be ſure to put aſmuch mettall into the furnace as may be ſufficient to fill the moulds; and euery mould (that is to be filled with Braſſe or any other Mettall) muſt haue ſpyralls or vents: for there is no place (although called empty) ſo voyd, but it is filled with Ayre, by meanes whereof if the hot meltes, ſubſtance come to meete with the Ayre there incloſed, not finding breathing vent, it will breake the the mould: wherefore it will be fit that as vpon the one ſide of the mould, the mettall is to come into it, vpon the other ſide the moyſture and ayre may breath out without impeachment, that all the emptines of the mould may be filled with mettall. And to that end there muſt bee a vent made that may breath out the ayre from the top to the bottome of the mould, concluding that by giuing the more and the larger enteries vnto the moulds and vents, the better and more faire will your matter bee caſt off. And ſo much for Foundings of Braſſe Ordnance.

Chap. XXII.

How to examine, search, and to finde whether any peece of Ordnance be well and duly made, and of what Kinde, and Sort it is.

THe principall thing that a Gunner ought to looke vnto, when hee is to take many Peeces of Ordnance into his charge, is first to search and examine how they are Fortified, and whether they be sound and safely seruiceable, and whether they be of the kinde of *Cannons of Battery*, *Culuerings*, or *Periers*, and then to know of which sort each Peece is of that Kinde; and then whether they be ordinary, re-inforced, or lessened in their Fortification of Mettall, and whether they be Cambred, either equall or Taper-bored, and with, or without an *Orlow* or *Relish*, be they of cast yron or of Brasse mettall: and of what heights their Bores are, and how much Powder they are each of them to shoote, with any Shot, be it of Lead, Iron, Stone, Granado, or other Fire-workes or Bales.

Secondly, that he looke how the *Spunges*, *Ladles*, *Rammers*, and *Waddhookes*, are fitted and conditioned, so that there may be no defect or default in them: And finding all those things well, hee is to place them all on the right side of the Cariages of the Peeces they belong vnto, so that the *Ladles* and *Spunges* be turned towards the mouthes, and the *Rammers* and *Waddhookes* towards the Breech of their proper Peeces.

Then by putting a *Rammer* with his staffe into the Peeces Concaue Cillinder as farre as it will goe, to know whether that Peece be cleare, loaded, or Cambered, and equall or taper-boared, with Relish, or not, or haue any foulenesse got into her Concaue Cillinder, which hee shall perceiue if hee make a marke vpon the staffe, at the mouth of the Peece, and pulling it out when it will goe no further in, and by laying it vpon the out-side of the Mettall, if it reach to the *Touch-hole* or not, for if it doe not reach thither, it is either loaded or cambred, or else some foulenesse is gotten into her. And if he finde or perceiue nothing to be within, yet he shall take her *Ladle*, and put it into her as far as hee can, and mouing it lightly about the lower part and bottome of her concaue, giuing two or three ietts, to receiue into the same, the dust or small stones or foulenes if any be in her, which he shall continue, drawing out the Ladle and emptying it, vntill hee perceiue there remaineth no more within her to be drawne out: Then placing the *Ladle* in his place, let him also take her *Spunge*, and spunge her well; to draw out all the moysture, rust, Verdegreace, or foulenesse, vntill she be cleane: then search also her *Touch-hole*, with a *Pryming iron*, whether shee be therein cleane, cloyed, or haue any foulenesse gotten into it.

That done, then may he with a common search vpon a staffe, hauing two or three round Pease, poynted springs that beare out, vnlesse they be forced close, put into the concaue Cillinder vnto the bottome, all along to examine her within whether there be any flawes, crackes, hony-combes, pynne-holes, sinders, or other faults: and the Sunne shining cleare, if the mouth

be

be turned againſt the Sunne beames, they may by a Looking-glaſſe well poliſhed, or with a bright ſword, be reuerberated into her concaue Cillinder: ſo that thoſe faults may bee therein moſt eaſily diſcerned; or elſe in cloſe weather or roomes, a Wax or other Candle lighted, being faſtned vpon the end of a Cane, ſtaffe, or halfe Pyke, her faults may bee ſpyed, if the ſame bee put into her hollow Cillinder, and carefully looked for all along, the *Gunners* eye being therefore imployed diligently at the mouth of the Peece.

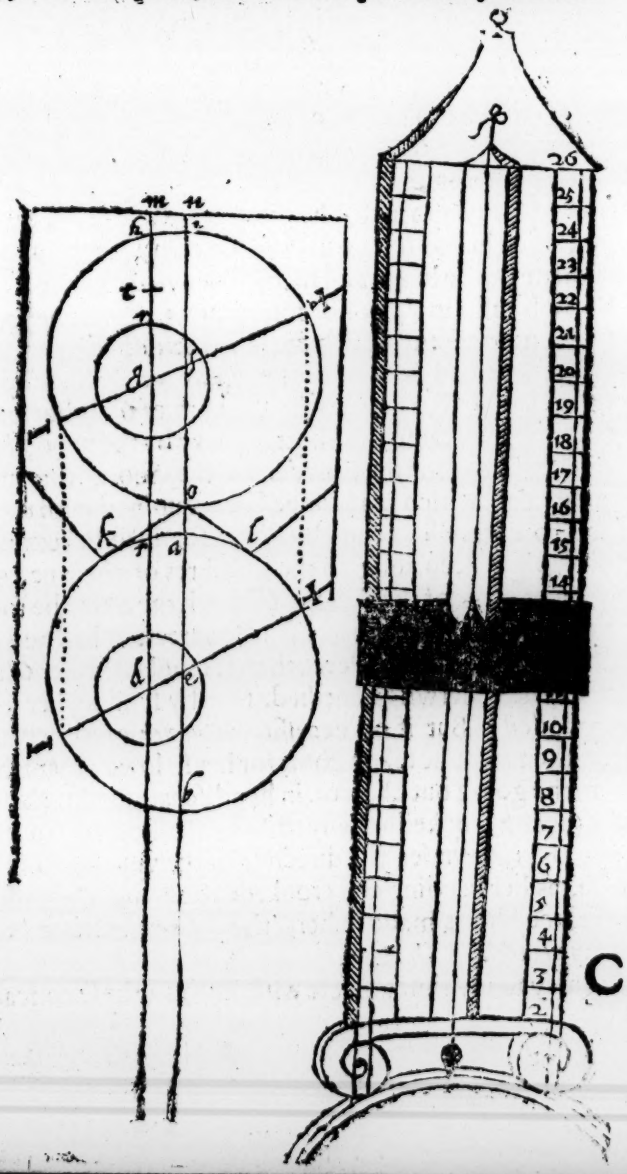
Wherein if he eſpye any creuiſes, flawes, cracks, or Hony-combes, hee may aſſure himſelfe that Peece is dangerous both for breaking by recharging of her too ſpeedily after her diſcharge, as well for her debillity by meanes of thoſe defects or faults, diſabling her to endure or reſiſt her ordinarie loading, or allowance of Powder to be fired in her, as alſo leaſt in ſuch Cauernes, flawes, or Hony-combes, ſome of the Wad, Carthouch, foulenes, furre, or Powder, lye ſmothering therein, and ſo vpon recharging, Fire, the Powder that ſhould loade her, vnleſſe ſhee be well ſpunged with wet ſpunges, with a great deale of handineſſe, care, and diligence, to bee aſſured to haue fully extinguiſhed the fire that ſhall ſo ſmother, before you recharge her. Beſides, much diſcretion and iudgement is to be vſed in the allowance of Powder, as in the manner of loading ſuch Peeces, notwithſtanding they be otherwiſe double fortified or re-inforced Peeces, yet to allow them (according as they are thereby more or leſſe weakened) ſo much more or leſſe Powder, as if they were of the leſſened poore, or ſlender, fortified Peeces of the ſame kinde and ſort.

It may many times happen that he may meete with Peeces that are wider at the mouth, then in the reſt of her bore within, which is often found in Peeces that haue beene long, and many times vſed to ſhoote Shott of Iron or ſtone, whereby the mouthes become enlarged, worne, and wider, by reaſon of the frequencie and vehemencie of their diſcharges, whereby the Gunner may be deceiued, if he take his meaſure for his Shot by the Callibre of her mouthes, for by that meanes the Callibre of their bores within being lower or leſſer, it may cauſe the Shott to ſticke by the way, and then a vacuity being in her betweene the Powder and the Shott, they will endanger the Peece to breake, which may ſoone bee examined with the *Croſſett*, deſcribed in the 19 Figure *a*, whereby Shott for ſuch Peeces may be ſafely choſen ſeruiceable, according to the Callibres of their narroweſt places, giuing abatement of $\frac{1}{10}$ of that height (though the Shott be round, and not ouall) for a conuenient vent, whereof more hereafter ſhall be ſpoken.

If he chance to meete with a Peece that is crooked in her *Chaſe*, which is a hard matter to be otherwiſe remedied, then by ſending her to the Furnace to be new Founded: But if by neceſſity a *Gunner* muſt needes ſerue with ſuch a Peece, then muſt he take a Shott for her ſo lowe, that it be ſure not to be hindred in the going out thereof, in her diſcharge. And beſides, he muſt accordingly (as the crookedneſſe lyeth) lay the Peece ſo much the contrarie way awry, ouer, or vnder the direction of the vpper part of the Mettall more or leſſe, as her bending and crookedneſſe is more or leſſe, the which after two or three Shotts made in her, the *Gunner* ſhall bee better directed then by many words.

Laſtly, he may many times meete with Peeces whoſe concaue Cillinder notwith-

notwithſtanding it proceedeth from the breech to the mouth directly ſtraight, yet it lyeth awry in the body of the Mettall thicker or more towards one ſide then the other, which commeth eyther by the ignorance or negligence of the Gunne-founder. The Mould not being ſo iuſtly fitted, that the ſolide *Cillinder* thereof, filling vp part of the vacuity of the outmoſt Colume of the Mould, thereby to make the *Concaue Cillinder* of the Bore, as to be ſcituated iuſtly in the midſt or right line of the *Axis*; The which is ſo great a fault, that if it be not well and artificially handled and ordered, it will be impoſſible to make a good ſhot therewith, beſides the dangers that depend vpon ſuch Peeces: for being thinne of one ſide, although it be thick on the other, yet muſt it be allowed no greater charge of powder then if the ſame were as thin on the thickeſt ſide as it is on the thinneſt, for if ſhe haue a charge of powder vſually allowed to good Peeces of that kind and ſort, ſhe will bee in great danger to ſplit or breake: wherefore very great care and iudgement muſt bee to fit her Charge according to her ability, and alſo to frame and place her diſpart duely, wherof alſo in his proper place hereafter, in the 26,27,& 28 Chapters, ſhall be more particularly declared.



CHAP.

Chap. XXIIII.

How to meaſure or Tertiate any Peece of Ordnance, to know how much Powder ſhe is able to beare for her due Charge.

THe beſt vnderſtanding experienced Forreigne *Gunners*, doe call the meaſuring and examining of the fortification of Mettall in a Peece, *Tertiating*, becauſe it is chiefly to be meaſured and examined in the three principall parts of each Peece: namely, at the breech, at their Trunnions, and at the mouth.

Now that euery induſtrious *Gunner* may be aſſured of the fortitude of any Peece of *Ordnance*, and ſo the more ſafely and boldly allow vnto her a due loading, and proportion of powder, for prooſe and ſernice, that ſhe may without danger performe her vtmoſt execution, I haue in the 18 figure described three *Cannons*, and three *Culuerings*, with the meaſures of their mettalls (their proper Bores being their proper Scale) at their Breeches or Chambers, & at their *Trunnions*, and at their *Mouthes*. The vppermoſt of both which, is the figure of a *Re-inforced* or double fortified, the two middlemoſt of an *Ordinary*, and the two vndermoſt of a Leſſened Peece, both *Cannons*, and *Culuerings*, with all their meaſures. By which alſo their ſorts, and all other Ordnance in their due meaſures, will be the better conceiued and manifeſted,

As for example there is a *Culuering* that ſhooteth an iron ſhot of 17 lb. waight with 13 lb. of corne powder, which is ⅘ of the waight of her ſhot; and the queſtion is whether ſhe may be able to beare ſo much powder, or if neede were more, which cannot be well anſwered without the examining or tertiating her mettall.

But hauing already ſearched her, as in the precedent Chapter is ſhewed, and found her ſound and free, except the defects therein mentioned, you may meaſure and tertiate her to anſwer the queſtion as followeth.

Firſt, with a Ruler, draw a right line vpon a paper ſlate or flat ſmooth boord, as in the ſaid 18 figure is deſcribed from A to B, Then with a paire of Compaſſes with ſtrait or reuerſed poynts, take the Dyametre or widenes of the Bore of the peece, and place that meaſure from A towards B at C, which ſpace betweene A and C, you muſt diuide into two equall parts, and then with the compaſſes opened to one of thoſe parts, ſet the ſame vpon another right line, as at the poynt D, and with the other foote draw a circle, which will be truely equall in Dyametre vnto the height of the Bore, as may appeare by the Circle A F C Q, and equall to the right line A C.

Then with a paire of *Caliber Compaſſes* take the thicknes or Dyametre of the mettall of the Breech at the *Touch-hole*: which diſtance betweene the poynts, you muſt diuide into two equall parts, and then the Compaſſes bee-

ing opened to one of them (and one foote set in D with the other) describe the other Circle GH, which shall be equall to the circumference of the mettall at the *Touch-hole*, and so the thicknes of the mettall or distance between the said 2 circles will shew the quantity betweene F and H, and E and G.

And seeing that the distance from F to H is equall to the distance from E to F, which is the Dyametre of the height of the Bore, he may be therefore sure that it is an Ordinary or Common fortified *Culuering*. But whether it bee either a Bastard or an extraordinary *Culuering*, it cannot bee knowne by the fortification, but by the length therof; being longer then the ordinary, it is called, therefore an extraordinary Culuering, &c. and being shorter then the Ordinary, it is therefore called a Bastard *Culuering*.

Now then this being found to be an ordinary *Culuering*, shee will beare $\frac{1}{4}$ of the weight of her shot in Canon powder, which amounteth vnto 13 lb. 9 oz. But to bee more assured of her fortitude, the measure of her mettall may be likewise taken at her *Trunnions*, and *Necke* as followeth.

At the Cornish or Ring before her Trunnions with a paire of Calibre Compasses, you may take the Dyametre of the body of mettall there, as you did before at the *Touch-hole*, and also diuide the distance betweene the points or ends of the compasses into two equall parts: with the compasses opened to one of those parts, setting one foote in D, make with the other the circle IL, and if you finde $\frac{7}{10}$ of the bore, it is the proportionall fortification for an ordinary Culuering; and the like may bee done for the Necke, which the circle MN will equalize and represent, and the distance from F to N being $\frac{1}{2}$ of the height of her bore, and the due thicknes of the mettall for an ordinary Culuering at the *Necke*, confirmeth the former measures and proofes.

But if in taking the Measures aforesaid, there had bin found in her Chamber at the *Touch-hole* from F to H the thicknes of one Dyametre of the bore, and $\frac{1}{10}$ more, it had beene a signe the Peece to be double fortified or re-inforced, hauing also at the Trunnions FL $\frac{11}{10}$, & at the Necke FN $\frac{9}{10}$ of the height or Calibre of her Bore, Then she shooting an Iron shot of 17 lb. would haue endured also 17 lb. of Cannon corne powder to be loaded with, and be fired within her without danger. And this would so haue conueyed the shot further then the ordinary could haue done, vpon like degrees of Mounture.

Contrariwise, if the circles there had beene found, that from F to H, but $\frac{7}{10}$ of her Calibre of the bore at the *Touch hole*, and at the Touch-hole but $\frac{5}{10}$ for FL, and at the necke from F to N but $\frac{7}{10}$ of the height of her bore. Then she appeareth to be one of the lessened or slender fortified *Culuerings*, and must be allowed but 12 lb. 9 oz. of Cannon corne to conuey her Iron shot of 17 lb. which vpon like eleuation will not cary a shot so far as the Ordinary, much lesse as the extraordinary *Culuerings* could haue done.

In this selfe same manner all sorts of Peeces of the second kind are to bee measured and *Tertiated* with this consideration and allowance withall, That the *Demy Culuering* hath $\frac{1}{12}$, and the *Saker* $\frac{1}{13}$, and the *Faulcon* $\frac{1}{8}$ more mettall comparatiuely then the whole *Culuering* hath. And so much for the sorts of the second kind of *Ordnance*.

Likewise vpon the other side of the same figure, the Measures of the *Ordnance* are thus described.

The

The double fortified or re-inforced *Canons* of Batterie, haue one whole Dyametre of their bore in thicknes of mettall at her *Touch-hole*, and $\frac{11}{16}$ at her Trunnions, and $\frac{7}{16}$ at her necke.

The ordinary *Canons* of Batterie is $\frac{7}{9}$ in their Chambers, $\frac{8}{9}$ at their Trunnions, and $\frac{5}{8}$ at their Neckes of the Dyametre of the Bores in thickneſſe of mettall.

The *Leſſened Canons* of Batterie is $\frac{3}{4}$ at the Chamber, at the Trunnions $\frac{8}{16}$ and at the necke $\frac{7}{16}$ of the Dyametre of their Bores in thickneſſe of mettall, whoſe poorenes and debility of mettall, although they be to ſhoote an Iron ſhot of about 60 lb. yet they cannot endure aboue 25 lb. $\frac{1}{2}$ of fine powder, or 31 lb. of common powder.

Whereas the *Re-inforced Canon* of Battery can endure to burne 34 lb. $\frac{1}{2}$ of fine powder or 43 $\frac{1}{2}$ of common powder.

And ſo the *Ordinary Canon* of Batterie will endure 30 lb. of fine, or 39 lb. of common powder.

But if the *Gunner* when he ſhould meaſure or tertiate any Peece, hath not Calibre compaſſes, he may doe it ſufficiently with a cord or ſtring, by guirding the Peece at the Touch-hole, at the Trunnions and at the Necke, taking $\frac{1}{7}$ part thereof for the Dyametre of the body of her mettall in each places, Thus:

The *Canon* or ordinary *Culuerings* haue about 11 Dyametres of their bore about at the Touch-hole, and at the Trunnions 8 Dyametres, and at the necke 6 Dyametres in their circumferences.

But the *Common* or *Ordinary Canons* of batterie haue but 9 Dyametres at the Touchhole, and at their Trunnions $7\frac{1}{2}$, and at their necks $5\frac{1}{2}$ in the circumference of their mettalls there.

Laſtly, the Demy Canons are but $\frac{7}{8}$ of their bores in thicknes of mettall at the Touch-hole: I need not to inſiſt vpon the reſt of the meaſures, nor of the Re-inforced Ordinary or Leſſened, onely I may ſay that as they all tend to none other end, but to make knowne the force and feeblenes of any Peece, to allow her a conuenient charge of Powder, that they may performe their beſt and vtmoſt force moſt ſafely: for if you giue any Peece more then her due charge in powder, you indanger the Peece your ſelfe, and the ſeruice expected, but if you giue leſſe ſhe cannot doe ſufficient execution.

The force and richnes, and the defects and pooreneſſe of the Powder, is likewiſe to bee well knowne for 10 lb. of one powder may doe more execution then 12 lb. of another, wherefore encreaſe or abatement muſt bee accordingly made to or from the quantity, that is ordinarily allowed, according to the ſtrength thereof, more or leſſe, whereof I intend to ſpeake more particularly in the chapter of the making and prooving of Powder.

But yet I will conclude with a briefe and induſtrious way to meaſure a Peece as is by the 19 figure 4 repreſented: Firſt draw a right line as the line C D, then take the wideneſſe of the bore of the Peece with a paire of ſtraight poynted compaſſes, and ſet both the poynts in the ſaid right line from C towards D, as C F which will be the height or wideneſſe of the bore of the Peece. Then with a paire of Calibre compaſſes take the Dyametre of the mettall at the breech, which being alſo ſet in the ſame right line from C to-

wards D as C E. Laſtly, diuide E E into two equall parts at A, ſo will F A or E A be the thicknes of the mettall at the breech. The like may be done at the Trunnions or Mouth.

CHAP. XXV.

To finde whether the Concaue Cillinder of any Peece of Ordnance bee in the midſt of her mettall, if not where the thickeſt or thinneſt of the Mettall is, and the difference thereof, and of the longeſt and ſhorteſt diſtances from the Axis of the mettall to the Axis of the bore, with their Larges and Diſparts.

BEfore I proceede any further, it will not be amiſſe here to ſhew the vſe of *Paralell Squire* deſcribed in the 19 figure *a*, which is an inſtrument requiſite to finde & examine whether that any Peece hath more mettal vpon one ſide of her then on the other. The ſame is of two perches or peeces made ſquare of good ſeaſoned wood planed ſtraight and ſmooth, ioyned at the end with two trauers peeces truely let in and well cloſed in their ioynts, ſo that as one of the pearches may come neerer or goe further off from the other as the Peece to be meaſured ſhall require alwayes, keeping the two pearches exactly paralell one to the other, and ſo locked with skrew pinnes and nuts, as that they may not boudge without his will that vſeth them.

Theſe pearches haue in each of them 5 or 6 skrewes with pins of braſſe or Iron, that the one pearch being put into the *Cillinder* of the bore of a Peece of Ordnance, the pins and skrewes with their halfe round heads may ſo beare vpon the lower ſide of the bore, that it may hold vp the pearch cloſe to the vpper ſide therof, all along euen to the Touch-hole. Then by the Trauerſes, locking the Perch that is without, that the further end may touch & reſt vpon the Baſering, and the vpper pinnes alſo touch the Corniſh frieze, and other eminent rings of the outſide. Then turning the ſaid inſtrument round about, all the concaue or foule within and about the mettall or body without ſide of the Peece, if you finde it to touch all parts equally in ſuch reuolution, you may be aſſured the Peece is truely bored in the midſt of the mettall; but if it touch not equally but bee ſtayde or ſtiffe vpon one ſide, and looſe, that the pinnes beare or touch not one the other, it is certaine that the ſide where it is looſe, is thinner in mettall, then the other where it goeth ſtiffe or ſtayeth.

The places which is thinneſt & thickeſt, being knowne by the ſtiffeneſſe or looſeneſſe of the pinnes in the turning, and the lengthning or ſhortning of thoſe pinnes more or leſſe, will alſo make knowne the quantity how much one ſide and place is thicker or thinner then another, and that throughout

euery

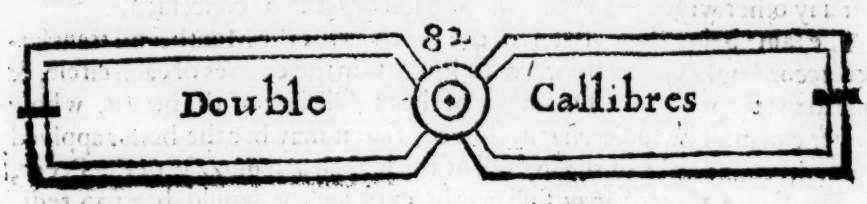
euery part of the Peece noting the thickeſt ſide with the Algebraicall figure of more thus —— and the thinner with the character of leſſe thus ⊣⊢, marking and noting very diligently how much the exceſſe is, and in either of thoſe places with a cord, or rather a parchment that will not ſtretch, guird the Peece round about, Then halfe-ing that guirting, by doubling it, lay one end of it vpon the character —— that is where the mettall is thickeſt, and where that halfe endeth there is the thinneſt by the 15 definition of the firſt of *Euclid*: which being done both at the breech and mouth alſo, and how much the thickeſt or thinneſt place is diſtant from the vppermoſt of the ſurface of the mettall in thoſe places ſeuerally noted; ſo much is particularly prepared for the ſame Peece onely, yet how it may be applyed in like ſort for any other wrybored Peece, may by like practiſe be conceiued.

The ſame being done aſwell for the Brech as for the Mouth, and transferred accordingly vpon a boord with Plumets in the centres of each circle, & one in the perpendicular Dyametre of the middle line of the boord, whoſe lower end muſt be ſomewhat hollowed, that it may bee the better applyed vpon the roundneſſe of the mettall of the breech and muzzle of the Peece, as the figure thereof may ſufficiently expl ine, it would bee too tedious, and not *opera pretium* further to deſcribe the perpendicill, or to demonſtrate the ſame, although I haue prepared for any friends that deſire it.

Note for as much as it is very difficil to reclaime ſuch Peeces from ſhooting awry, or ouer or vnder, without theſe curious preparations: And becauſe they are not ſafely to be ſhot in, without very good and mature conſideration of their weakenes and danger, for if an ordinary charge of powder be fyred in ſuch a Peece, the weaker fortified part would not be able to reſiſt the force thereof, but be in great danger to breake and ſplit. therefore I would aduiſe euery Gunner that ſhall be appoynted to ſerue with ſuch a Peece, aſwell for his ſafety as for his credite, eyther with or without reclaim ng thoſe Errors, not to load her with more powder then if ſhee were no better fortified in any place then ſhe is in the weakeſt part, her ſurpluſſage at the thickeſt, being no better helpe to ſtrengthen the thinneſt of her mettall; then if ſhe were in all places weake alike. Yet to examine the mettall of any Peece doe thus alſo, Mount the mouth of the Peece vpon a skidde or peece of Timber, and hauing from the vpper part of the mettall, made foure markes, or diuided the circumference of the Baſe and Muzzle Riggalls or Rings into 4 quadrants from the mouth to the Breech, hauing ſtretched a chalke line layd vpon two of thoſe marks each with his match, ſtriking with that line, 4 lines alongſt vpon the outſide of the body of the peece, and hauing a great care that they be truely lined; Then take a ſtrait rod and put it into the mouth of the Peece, holding it cloſe to the ſide of the concaue directly within it as the lines directeth, the one line whereof lying directly, his oppoſite will lye directly vnderneath it, and the other two lines will bee ſtretched on both the ſides of the Peece.

Then take your Quadrant, and place one ſide thereof euen with the rod, and looke what degree the perpendicular plumlyne cutteth thereon, and ſo turning the peece, that one of the ſyde lines may then lye vpright, if the plumblyne then fall vpon the ſame degree at each line of ſuch application

vpon them all, the Peece is then truely bored. Lastly, there may also for that purpose be an Iron or Brasse Instrument with a ioynt in the midst called Double Calibres with foure legges like the figure here described, which by putting them into the concaue of the Peece, and turning it round within the bore, clasping the other legge without to the mettall of the Peece, the distance betweene the other two legges without will shew the thickenesse of the Peece in each part, and shew, with applying all the openings vnto an inch Rule or scale of equall parts, whether the Peece bee thicker vpon one side then on another, being alike distant from the mouth of the Peece, and how much and where.



Which differences of thickenesse and thinnesse of her mettall, wry boring or vneuen lying, of the concaue Cillinder or Soule in her body or Mettall being so made knowne. The Large lyne and Large it selfe, together with her due dispart, and lying of the Axis, for such a Peece may be found as followeth.

Chap. XXII.

To Dispart a Peece of Ordnance, whose Bore lyeth horizontally awry, and the Axis thereof being paralell to the Axis of the Mettall.

Suppose that the Bore of the Peece lyeth awry so much of the Horizontall Dyametre square, as *w v*, or of the circumferences of the mettall at the mouth, as *m n*, or at the Breech as *t r*, here represented by the two paralell right lines, one *v b m t*, being the verticall semidiametre of the middle of the mettall at the Breech, and *v b m* at the mouth. And *w b o n t* the other parallell, whereof *w b* is the verticall semidiametre of the middle of the bore both at Breech and Mouth, and *h n* the verticall thickenesse therein of the mettall of the mouth, and *h t* the verticall thicknes of the mettall at the greatest ring at the breech.

The difference of *b m* for *h n* being added vnto the difference of *m r* from *t r*, augmented by the lyne of the vsuall dispart *r m* (the difference at the vpper part of the mettall at the Breech and Mouth) will compound and make the due dispart little or nothing differing from the vsuall dispart, but must be placed

placed vpon *n* perpendicularly paralell to *m r*, which shall direct the sayde Peece to make an assured good shot, the visuall line passing from the Gunners eye by *t* and *n* vnto the marke to be shot at, by the 10 definition, and the 65 *Theoreme.*

But if the Bore or Soule of the Peece lye awrye, the Axis thereof not being paralell with the Axis of the Mettall.

As if the Bore at the Touch-hole were as the circle *x b y d.* and the Bore at the mouth, as *e g h f*, and the Axis of the Bore passeth from *v* at the breech vnto *w* at the mouth horizontally leuell with the Axis of the mettall; Then shall the *Dispart* be of such length, as in the former ordinary manner, but the dispart lyne vpon the mettall at the breech will passe directly from poynt *z*, vnto the poynt *n* at the mouth of the peece, to make a perfect shot with such a peece at any marke assigned.

Chap. XXVII.

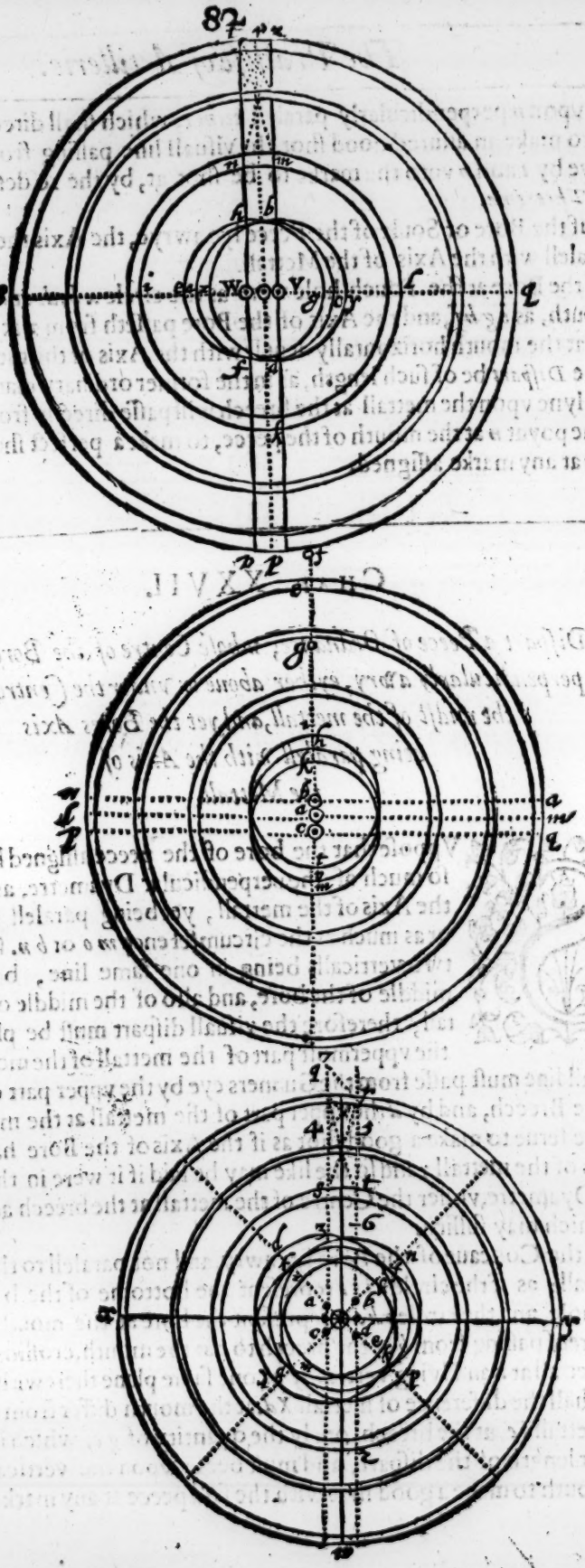
To Dispart a Peece of Ordnance, whose Centre of the Bore lyeth perpendicularly awry, eyther aboue or vnder the Centre of the midst of the mettall, and yet the Bores Axis being paralell with the Axis of the Mettall.

Vppose that the bore of the peece assigned lyeth awry so much of the perpendicular Dyametre, as *a b* aboue the Axis of the mettall, yet being paralell thereunto, or as much as the circumference *m o* or *b n*. Herein the two verticalls being in one same line, both of the middle of the bore, and also of the middle of the mettall; therefore the visuall dispart must be placed vpon the vppermost part of the mettall of the mouth, and the visuall line must passe from the Gunners eye by the vpper part of the mettall at the Breech, and by *d* the vpper part of the mettall at the mouth, and will there serue to make a good shot as if the Axis of the Bore had lyen in the Axis of the mettall; and so the like may be said if it were in the perpendicular Dyametre, vnder the Centre of the mettall at the breech and mouth, as *a c*, which may suffice.

But if the Concaue of the Bore lye awry, and not paralell to the Axis of the mettall; as if the circle *r i s t* represent the bottome of the bore at the Touch-hole, and the circle *r k s w* represent the bore at the mouth, and the Axis thereof passing from *b* at the breech to *c* at the mouth, crossing the Axis of the mettall at *a* and lying vertically in one same plane therewith.

Then shall the difference of mettall *x d.* at the mouth differ from the thicknes of mettall *i e*, at the breech, onely the quantity of *g e*, which is the true height or length of the dispart, and must bee set vpon the verticall point *d* at the mouth to make a good shot with the said peece at any marke assigned

to



to be shot at within the distance. For take *k d* out of the mettalls at the mouth of *i e*, the mettalls are at the breech, and will rest *g e* the Dispart sought.

But if the Circle *r k s w* be the Bore at the breech, and *r i s v* the bore at the mouth.

Then shall the thicknes of the mettall at the Mouth *i d* differ the thicknes of the mettall at the breech *k e* the full quantity of *d f* the true dispart for the same Peece to bee set vpon the verticall point *d*. As *d f*, to make a good shot at a marke assigned. For take *i d*, the mettall at the mouth out of *k e* the thicknes of mettall at the breech, and there will rest *i e* equall to *d f*, for the dispart sought, by the 10 Definition, and the 8 Demand.

Chap. XXVIII.

To Dispart any Peece of Ordnance, whose Axis of the Bore lyeth awry not leuelly nor vertically, the Axis of the Mettall not being paralell thereunto.

AS suppose first that the bore at the breech bee represented by the excentricke circle *d g e f*, and at the mouth by the excentricke circle *o f p g*, and the Axis of the bore the right line *a d*. The outmost circle of the mettall at the breech by the concentricke Circle *q r y w x*, and the outmost circle of the mettall at the mouth by the concentricke circle *s t z*: So shall the thickneſse of the mettall at the breech be 3 *q*, and the thicknes of the mettall at the mouth bee 2 *t*, which space or quantity 2 *t* being taken out of 3 *q* leaueth 4 *q* the dispart required, to be set vertically vpon the mouth at the poynt *t*, because the same is the point in the outmost mettal of the mouth that is vertically ouer *d*, the Centre of the bore at the mouth, and the large line shall be *q t*: for that *q* is right and vertically ouer the Centre of the bore vpon the outmost mettall at the breech, and *q s* will be the dispart line and part of the sight line that must passe from the *Gunners* eye by the poynt 9 on the Mettall at the breech, and by the point 5 the top of the dispart, set vpon the point *t* at the mouth, and so extending it selfe vnto the Centre of the marke assigned to be shot at. The like may bee said if *b* were the Centre of the bore at the Touch-hole, and *c* the Centre of the bore at the mouth: For then would *r s* be the large line, and *r 4* the dispart line, and 4 *s* the dispart, each reciprocally answering the forenamed measures, being only placed alike on the contrary side which may suffice.

But if *d* were the Centre of the bore at the Touch-hole, and *a* were the Centre of the bore at the mouth.

Then would 3 *s* be the thicknes of the mettall at the mouth, which being taken out of 3 *r* the thicknes of the mettall at the breech, there will rest 6 *r*

to be set vertically vpon the vpmost mettall of the mouth at *s*, because *s* is the verticall point there ouer *d* the Centre of the bore at the mouth of the Peece, so shall 6 *r* or 8, 7 equall thereunto be the length or heigh of the dispart, and *r s* shall be the large line, vpon the mettall passing from the breech to the mouth; and *r* 7 shall bee the dispart line, part of the sight-line that passeth from the *Gunners* eye by the points *r* and 7, and extendeth vnto the Centre of the marke assigned, by the 10 definition and the said 8 Demand.

CHAP. XXIX.

Of the Larges, and the Large Line in vry bored Peeces.

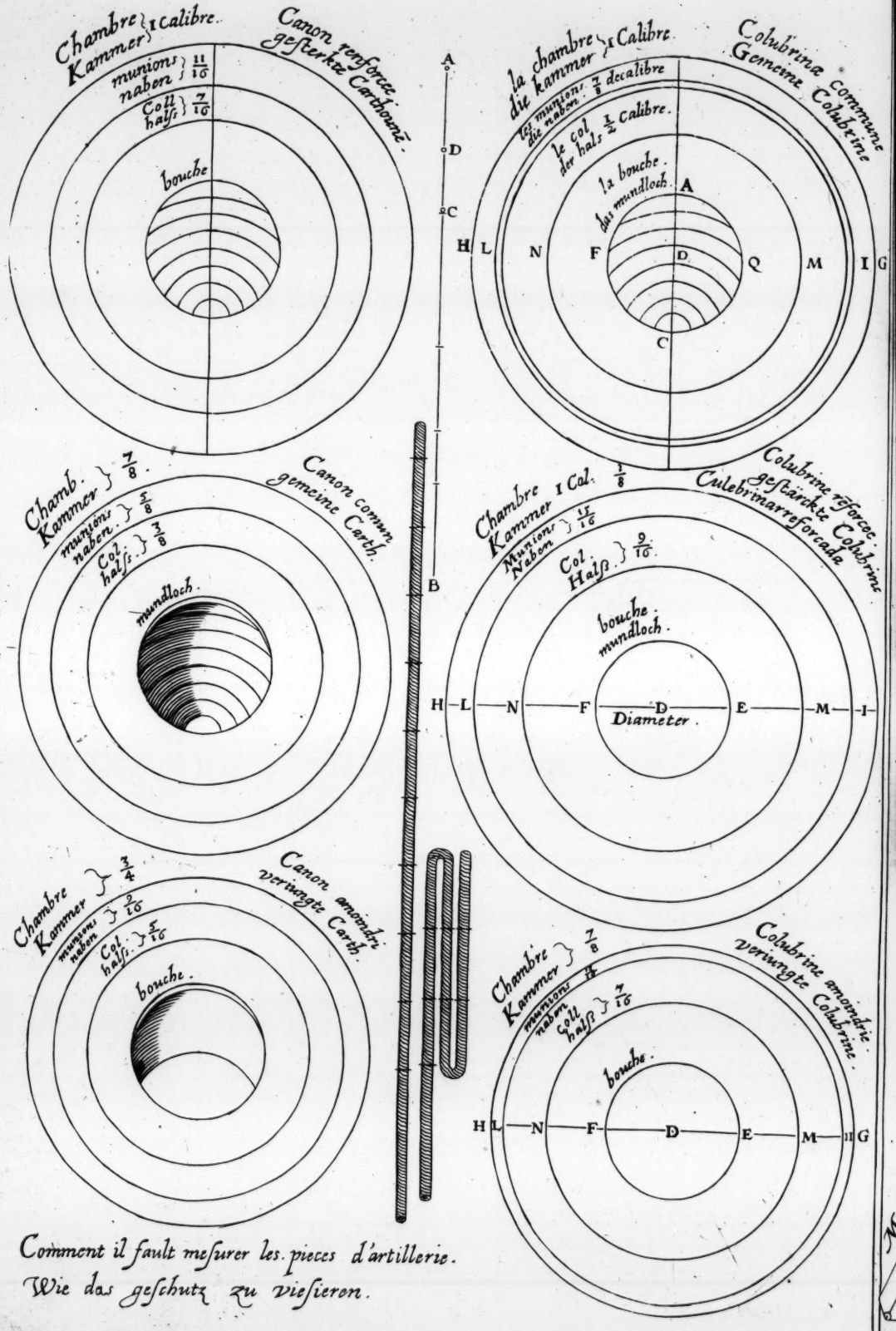
HAuing already shewed how to finde whether the Peece assigned were equally bored in the midst of the mettall, if not where the thickest and thinnest of the mettall lyeth, it resteth now to shew also how to find her middle line, or highest of her mettall at the breech and muzzle, as also her large and large line in a peece that is bored or cast awry.

The Middle line is none other thing, but an imaginary *Right line* supposed to passe vpon the highest of the mettall of a Peece of *Ordnance* from her Base ring to her Muzzle ring, directly and vertically ouer the Axis of the body of mettall of that Peece, which by the perpendicill aforesaid is easily found by placing the two corners K and L seuerly vpon the Base and Muzzle rings in such sort as that the plummet belonging to the line *n, o*, may hang directly ouer the same line, and being let downe, vntill the poynt thereof doe touch vpon the surface of the mettall there, make poynts or pricks at each place, I say then that those points will be directly ouer the Axis of the Mettall of that Peece, betweene which points if a Chalke line be stretched and striken, or a right line imagined to passe, the same shall be the *middle line* of that Peece.

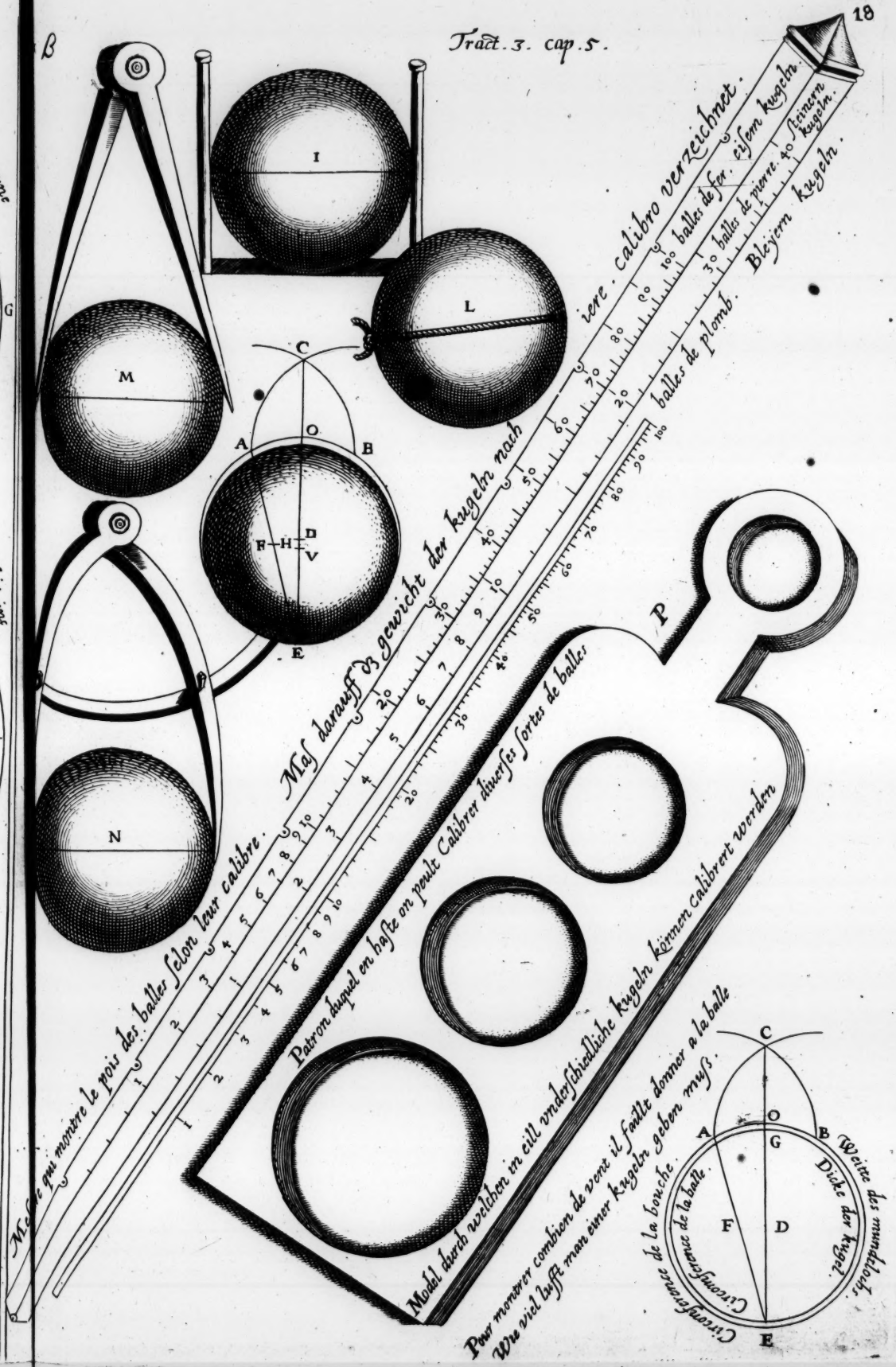
Now to finde the *Large lyne*, and the Large it selfe, in such Peeces as are bored, or cast awry: Hauing found the midle Line, and the Plummet hanging so directly ouer *n. o.* vpon the said markes; and hauing found the Excentricke circles of the thickest, and thinnest of the Mettall, at the Breech, and Mouth, and described them vpon the Perpendicill, as is afore shewed, with their Perpendicular lines parallell to *n. o.* letting downe their Plummets, each in his proper place seuerally, so that it hang directly ouer his owne Perpendicular line, and that the point of the Plumet also touch the Superficies of the Mettall, and there at each touch, make a marke and stretch a chalke-line betweene them, from the Base to the Muzzle rings, and strike a line vpon the Mettall therewith, or else imagine a right line to passe betweene them; I say, that line will bee Vertically ouer the Axis of the Bore, of that Peece, and is the Large line sought, and the distance betweene the extremes of the midle line formely found, and this *Large line* vpon the *Base*

and

DEC



Comment il fault mesurer les pieces d'artillerie.
Wie das geschutz zu viesieren.



Mesure qui montre le pois des balles selon leur calibre.
Mas darauff dz gewicht der kugeln nach iere. calibro verzeichnet.
balles de fer. eisern kugeln.
balles de pierre. steinern kugeln.
balles de plomb. Bleyern kugeln.
Patron duquel en haste on peult Calibrer diuerses sortes de balles
Model durch welchen in eill vnderschiedliche kugeln können calibrert werden
Pour montrer combien de vent il faillt donner a la balle
Wie viel lufft man einer kugeln geben muss.
Circonference de la bouche.
Circonference de la balle.
Weitte des mundtloths.
Dicke der kugel.
A
B
C
D
E
F
G
O
I
L
M
N
P

and muzzle rings noted, are the Large it ſelfe: and ſo is that Peece reclaimed and prepared to auoid wide ſhooting.

Now it reſteth alſo to reforme her ouer, or vnder ſhooting, whoſe cauſe may by the former ſections bee conceined, and by the perpendicill eaſily, and readily found and performed thus: Firſt, vpon the marke vnder *o*, where the plumet touched, place a due Diſpart for her, as if ſhe were truely bored; then if the Centre of her Bore, at her breech bee found by the inſtrument, to be vnder the Centre of the Bore, at her Muzzle; the difference thereof, is then to bee ſubſtracted, from the leuell height of the Diſpart: But if the Centre of the Bore at the breech, bee higher then the ſame at the mouth, then that difference muſt be added, and placed vpon the marke of the Large, at the muzzle, with that addition, or abatement; and ſo the viſuall line, muſt paſſe from the Large, at the breech, by the top of that Diſpart there placed, which will auoyd all ouer, or vnder ſhooting in that Peece.

Chap. XXX.

To finde the waight of any Shot by the Diametre thereof, as well Arithmetically, and Geometrically, as Tabularly, and by Scale, and Compas.

THe weight of the Shot, being a fit Index for the *Gunner*, to allow any Peece of *Ordnance* her due charge of powder, is therefore moſt neceſſary to bee made knowne, or firſt fought; and becauſe a *Gunner*, cannot at all times when the weight of a Shot is required, haue Ballance and weights about him, to waigh the ſame; therefore, it ſhall not bee a miſſe, here to ſet downe, how hee may know the ſame, to a ſufficient neereneſſe, by the height of the Dimetre, or circuit of the circomference thereof; And that alſo for varietie ſake, as well *Arithmetically*, and *Geometrically*, as *Tabularly*, and by *Scale*, and *Compas*.

The firſt thing to be done in Arithmeticall working, is to finde the ſolide ſquare inches, contained in the Ball, or Shot aſſigned; which may bee thus found, multiply the meaſure of the knowne inches of the height, or Dyametre thereof Cubickly, and then againe multiply that Cube by 11, and diuide the laſt product by 21, and the number in the Quotient, will expreſſe how many ſolid ſquare inches of Mettall, or Stone is contained in the Globall body of that Shot: If then you know, how much one ſquare inch of the Mettall, or Stone aſſigned weigheth, you may then ſoone know the whole Shots weight ſought, (for caſt Iron 4 ownces allowed for each inch ſquare, commeth neere the matter) and the proportion of Iron to Lead may be as 30 to 46: And ordinary Stone to Lead, as 18 to 72, and Stone to Iron, as 18 to 48, tollerable accepted.

But to come more precifely neere the trueth (although ſpungineſſe) and the

difference of each Mine from other, and infinite accidents, vary the proportions betweene their capacities, and weights, and doe hinder it. The table following will ſufficiently helpe, in the meane ſpace, I will giue one example to illuſtrate the precedent rule. As for example, it is required to finde thereby the ſolid ſquare inches, in a Shot of 4 inches and $\frac{1}{2}$ in height; the neere Cube of $4\frac{1}{2}$ being need 91, which I multiply by 11, & the product I finde to be 1001, which I diuiding by 21, finde in the Quotient 47 inches, and $\frac{7}{21}$ of an inch more, for the ſolid content of that Shot, which if it were of Iron, by ſuch allowance as aforeſaid, it would weigh 11 lb, & about 15 ounces, but by the firſt Table following, it would be 12 lb. and 12 ounces, and by the ſequent treble Table for Lead, Iron, and Stone Shots, it is found to bee but 12 lb. and 10 ounces, wherein appeareth alſo that a Leaden Shot, would bee 17 lb. and 15 ounces, which by the firſt Table, would bee found 19 lb. and 12 ounces. But, for ſome eaſineſſe (and becauſe it may for any Iron Shot be wrought by memory, by a man of any ſmall practiſe) doe vſe onely to diuide the Cube of the Shot by 8, and take the Quotient for poundes, and each vnitie of the remainder for 2 ounces, and ſo the Cube of $4\frac{1}{2}$ being 91, as aforeſaid, and diuided by 8, the Quotient will bee 11 lb. and the 3 remaining will bee 6 ounces: The like in all kindes may bee done for Stone Shot, by the rule of 3 onely, ſaying, if 48 the proportion of Iron, giue 202 ounces, what ſhall 18 the proportion for ſtone giue? 76 ounces, which will bee 4 lb. and 12 ounces for the weight of the Stone Shot, that is 4 inches and $\frac{1}{2}$ in height.

But the moſt artificiall, and exact Arithmeticall working of all ſuch queſtions, for all vſuall Mettalls and Stones, is according to the next Table, wherein, I haue imitated the Lord *Marchiſtones* Table, in his *Rabdologia*, applying this vnto ounces, and inches, which are our vſuall knowne weights and meaſures: Whereas his was for Cochleas, or Spoonefulls, and Drames, more vſed by Phyſitians, then knowne in Gunners practiſes; yet, for his two firſt Theoremes, and Problemes, I haue followed them, becauſe their workes are eaſie, and excellent.

The firſt Probleme.

By the inches of the capacitie, of the Mettall, or Stone named, to finde the ounces of the weight thereof.

The firſt Theoreme.

As a 1000 to the inches of the capacitie, or ſolid meaſure of the Mettall, or Stone named; So is the loweſt number of the Colume, of the ſame Mettall, or Stone, to the ounces of the weight thereof.

The firſt Example.

Let there be an Iron Shot of 8 inches high, which by ſolid meaſuring, (as aboue is taught) is found to containe 268 inches, and $\frac{1}{7}$: By the ſaid firſt Theoreme, as 1000, to $268\frac{1}{7}$, ſo is 4333 the loweſt number of the Colume of

of Iron, vnto 1162 ounces which being diuided by 16 (the ounces of the Haberdepoiſe,) amounteth vnto 72 lb, and 10 ounces the weight ſought.

The ſecond Example.

Let an ordinary Stone ſhot, of the ſame height and meaſure be propounded, containing as aforeſaid, 268 inches $\frac{1}{7}$, ſay, by the ſame firſt Theoreme, as 1000 is to 268 $\frac{1}{7}$, ſo will 1420 the loweſt number of the Colume, of ordinary ſtone thereof, bee to 382 ounces, which the Stone ſhot weyeth; they being reduced into pounds by deuiſion thereof by 16, will amount to 23 lb. 14 ounces, the weight of Stone ſhot ſought.

The ſecond Probleme.

By the ounces of the weight of any Mettall, or Stone named, to finde what number of ſolid inches it is in capacitie.

The ſecond Theoreme.

As 1000 to the ounces of weight of any Mettall, or Stone named, ſo is the moſt right hand number of the Line, of the ſame Mettall, or Stone, to ſolid inches of the capacitie thereof.

The firſt Example.

Let there be a Shot of Iron of 8 inches Dyametre, weying 1162 ounces, and wee deſire to know, how many ſolid inches it containeth: By the ſecond Theoreme, as 1000 to 1162, ſo is 230 the moſt right hand number, in the Line of Iron to 268, fere the ſolid inches contained therein.

The ſecond Example.

Let there bee a Shot of ordinary Stone, whoſe weight by the ſecond example of the firſt Theoreme, will be 23 lb. and 14 ounces, whereof the ſolid inches is required: By the ſecond Theoreme, as 1000 is to 382 ounces the weight, ſo is 710 the moſt right hand number, of the line of ordinary Stone, to 270 fere the ſolid inches required; exactneſſe by Table, is not to bee expected.

A Table for the Weights, and Meaſures, of Mettalls, and Stones.

Gold.									
1000	810	670	645	380	420	410	170	130	120
Quickſil.									
1392	1000	950	820	678	568	550	210	150	140
		Lead.							
1650	1150	1000	910	740	675	635	250	160	160
			Siluer.						
1785	1340	1248	1000	820	710	750	270	200	180
				Braſſe.					
2225	1680	1448	1345	1000	925	850	320	240	200
					Iron.				
2588	1930	1670	1535	1190	1000	930	380	260	230
						Tinne.			
2725	2045	1765	1640	1280	1160	1000	420	280	250
							Marble.		
6780	5120	4278	4090	2216	2784	2642	1000	710	680
								Ord.ſto.	
9960	7415	6405	5948	2650	4020	3828	1530	1000	710
13200	7880	6798	6315	4958	4333	4067	1645	1420	1000

Chap. XXXI.

The Geometricall finding the Dyametre, for the weight of any Shot aſſigned.

HAuing a Shot of one pound, 2 lb. or 3 lb. weight of the Mettall, or ſtone aſſigned; if it bee of one pound, diuide the Dyametre thereof into 4 equall parts, and 5 ſuch parts, will make a Dyametre for a Shot of the ſaid Mettall, or Stone, that ſhall weigh iuſt two pound.

And diuide the Dyametre of a Shot, that weigheth iuſt 2 lb. into 7 equall parts, and 8 ſuch parts, will make a Dyametre for a ſhot of 3 lb. weight.

And diuiding the Dyametre of a ſhot of 3 lb. weight, into 10 equall parts, and 11 ſuch parts, will make ſhot of 4 lb. weight.

And diuide the Dyametre of a ſhot of 4 lb. into 13 parts, 14 ſuch parts, will make a Dyametre for a ſhot of 5 lb. weight.

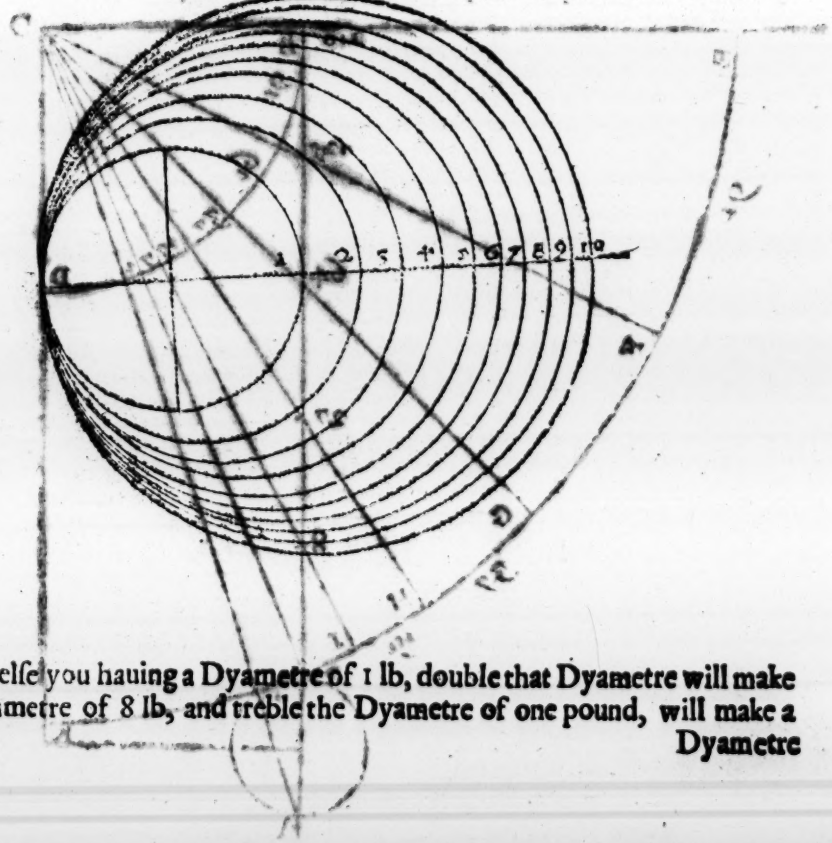
And diuiding the Dyametre of a ſhot of 5 lb. weight, into 16 equall parts, 17 ſuch parts, will make a Dyametre of a ſhot, that will weigh 6 lb: And

ſo

so diuiding each next Dyametre into 3 parts equall more then the next lesser was diuided into, and it will with one part added frame a Dyametre of a shot, that will weigh iust one pound more; and so you may proceed infinitely, increasing, or decreasing, by taking one part lesse, then it is appointed to be diuided into, for 1 lb. lesse, and the next into 3 lb. lesse, to abate one from the remainder, infinitely decreasing it.

A second Geometricall way.

Hauing exactly the Dyametre of a shot that weigheth one pound; first describe a Circle, whose Dyametre shall bee iust equall thereunto, and diuide it into 4 Quadrants, with two Dyametres, cutting each other in the Centre Orthogonally, then take the Chord of the whole Quadrant, or of 90 Degrees, that is, extend your Compasses, from one extreame of a Dyametre, to the next, as in the figure following: Take the distance A. B, being supposed the Dyametre of a shot, or ball of iust one pound weight, which distance being set in the continued right line D. B. *f. g. h*, and from E. to *f*, then will D. *f*. bee the Dyametre of a shot of 2 lb, and then opening the Compasses from A. to *f*, and setting the same from E. to *g*. Againe, taking the distance from A. to *g*, and setting it from E. to *h*, so likewise taking the distance A *h*. with the Compasses, and setting the same from E. to *i*, and so continuing vntill you haue proceeded as farre as you will: You shall finde if D. B. were the Dyametre of 1 lb. that D. *f*. will be the Dyametre of 2 lb, and D. *g*. will be the Dyametre of a shot of 3 lb, and D. *h*. of 4 lb, D. *i*. 5 lb, D. *k*. of 6 lb, and D. *l*. of 7 lb, and D. *m*. of 8 lb, &c. and lastly, D. *q*. of 12 lb, whereby you may proceede in like manner infinitely.

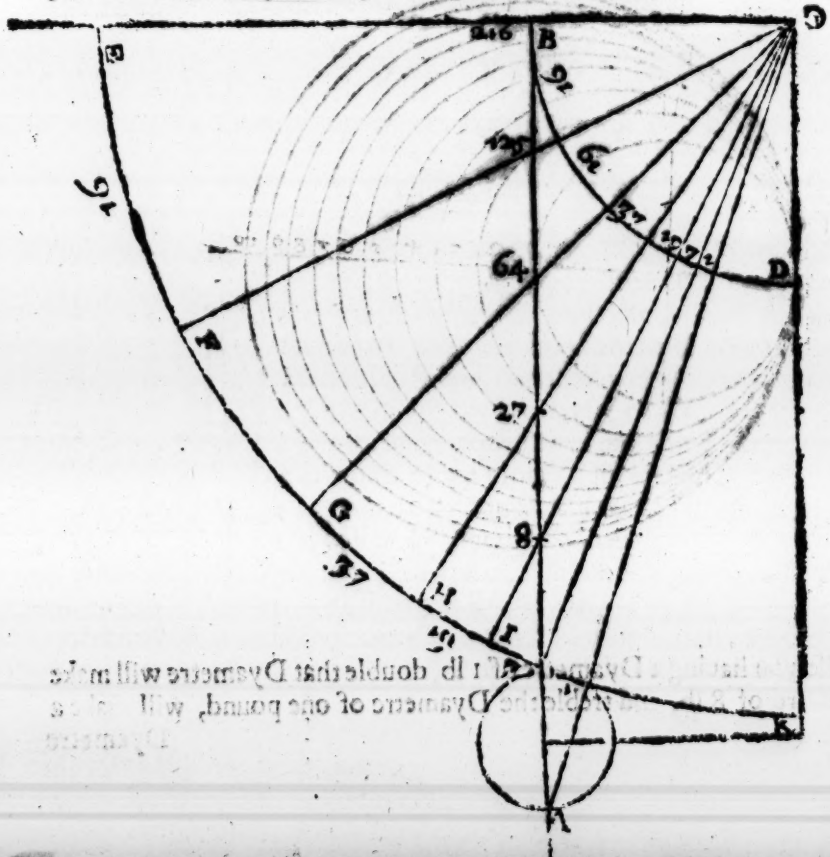


Or else you hauing a Dyametre of 1 lb, double that Dyametre will make a Dyametre of 8 lb, and treble the Dyametre of one pound, will make a

Dyametre

Dyametre of 27 lb. and the quadruple, or 4 times the ſame will make a Dyameter of a ſhot of 64 lb, and 5 Dyametres, will make a Dyametre of a ball of 125 lb: and fiue times the Dyametre of a ſhot of 1 lb, will make a Dyametre of a ſhot, that will weigh 216 lb.

It reſteth now, to ſhew how to finde the meane diuiſions betweene thoſe extreames, as for the Dyametre of a ſhot of 2 lb, 3 lb, 4 lb, 5 lb, 6 lb, 7 lb, and more: ſo as by ſuch progreſſions, you may proceed from pound to pound, vntill you come to the laſt tearme, for extreame of 216 lb. Neuertheleſſe, the ſame manner of working will proceed infinitely; the former mentioned fiue Dyametres, being marked vpon one and the ſame right line, you muſt at the end of them, draw another right line Orthogonally, and ſet therein two ſuch Dyametres, as at C, and from thence, draw another right line paralell to the firſt, from C. to K, then put one foote of your Compaſſes in C, and make a quarter of a Circle from B. to D, that done, plant a pinne, or needle in C, and then draw from the Center C. lines through all the diuiſion of the Dyametres, marked vpon the right line A, B, ſo ſhall you haue fiue diuiſions to be diuided: The firſt being diuided already, abideth as it was, and is the Dyametre of a ſhot, or ball of one pound; but the ſecond diuiſion, is to bee in the circumference, diuided into 7 parts equally; becauſe it containeth the ſecond Dyametre vnto 8, from 1 to 8, for adding 1 to 7, it maketh 8; the third diuiſion is into 19 equall parts, which being added to the 8, maketh 27; the fourth, ſhall bee diuided into 37 equall parts, which together with the 27, maketh 64, the fift ſpace ſhall bee diuided into 61 equall parts, which together with the 64, amount vnto 125; and laſtly, the ſixt ſpace muſt be diuided into 91 equall parts, vnto which adding the 125, you ſhall make a Dyametre, for a ſhot of 216 lb. iuſtly.



Now

Now for as much, as these diuisions are deficill, to make well within so small a Quadrant, you may therefore describe a greater, as the Quadrant K. E, wherein the diuisions are more distinct, then in the lesser they can bee; further you may note, that Fire-balls, Granadoes, and other Globous Artifices; must haue the same proportion in their Grandures, from their Ball of one pound, which may bee exactly considered: and so by this method, you may make Balls of Lead, Brasse, Stone, Granadoes, Fire-balls, and all other Spherical workes, of what weight you will, hauing one of one pound first to lead you, according to the precedent instructions.

A Table whereby, and by the Inch sight-rule, any Peece of Ordnance betweene sixe foot, and fifteene foot in length, may bee mounted to any Degree of the Quadrant, vnder twenty Grades, as well as by the Quadrant it selfe, *or by any other Instrument whatsoeuer.*

	Foot.		Foot.		Foot.		Foot.		Foot.		Foot.		Foot.		Foot.		Foot.		Foot.
	6	½	7	½	8	½	9	½	10	½	11	¼	12	½	13	½	14	½	15
Gr.	Inch.																		
1	1, 2	1, 3	1, 4	1, 5	1, 6	1, 7	1, 8	1, 9	2, 0	2, 1	2, 2	2, 3	3, 2,	4, 3	5, 2	6, 2,	7, 2	8, 2	9, 3, 0
2	2, 5	2, 7	2, 9	3, 1	3, 3	3, 5	3, 6	3, 8	4, 0	4, 2	4, 5	4, 7	5, 0	5, 2	5, 4	5 6	5, 8	5, 9	6, 0
3	3, 7	4, 0	4, 3	4, 6	4, 9	5, 3	5, 5	5, 8	6, 0	6, 3	6, 7	7, 1	7, 4	7, 8	8, 2	8 4	8, 8	9, 0	9, 2
4	5, 0	5, 4	5, 8	6, 2	6, 6	7, 0	7, 5	7, 9	8, 4	8, 8	9, 2	9, 7	10, 0	10, 4	10, 8	11, 2	11, 6	12, 0	12, 4
5	6, 2	6, 8	7, 4	7, 8	8, 2	8, 7	9, 3	10, 0	10, 5	11, 0	11, 5	12, 0	12, 5	13, 0	13, 6	14, 2	14, 8	15, 2	15, 5
6	7, 5	8, 2	8, 9	9, 4	9, 9	10, 4	11, 0	11, 9	12, 6	13, 4	14, 6	14, 8	15, 0	15, 7	16, 4	17, 1	17, 8	18, 3	18, 8
7	8, 7	9, 5	10, 4	10, 9	11, 7	12, 1	12, 8	13, 8	14, 5	15, 3	16, 0	16, 7	17, 4	18, 2	19, 0	19, 9	20, 8	21, 3	21, 8
8	10, 0	10, 8	11, 9	12, 3	13, 3	13, 8	14, 2	15, 8	16, 6	17, 5	18, 3	19, 2	20, 0	20, 8	21, 6	22, 7	23, 0	24, 2	24, 6
9	11, 3	12, 3	12, 5	13, 7	14, 5	15, 1	15, 9	17, 7	18, 7	19, 7	20, 6	21, 5	22, 4	23, 4	24, 4	25, 0	25, 8	26, 6	27, 2
10	12, 3	13, 0	13, 8	15, 4	16, 7	17, 7	18, 7	19, 8	20, 8	21, 9	22, 9	24, 0	25, 0	26, 0	27, 0	27, 8	27, 9	29, 2	30, 8
11	13, 7	14, 8	16, 3	17, 0	18, 4	19, 4	20, 4	21, 7	21, 7	24, 0	25, 4	26, 8	27, 4	28, 5	29, 6	31, 1	32, 6	33, 3	34, 0
12	15, 0	16, 2	17, 5	18, 7	20, 0	21, 1	22, 2	23, 5	24, 8	26, 2	27, 6	29, 0	30, 0	31, 2	32, 4	33, 7	35, 0	36, 2	37, 4
13	16, 2	17, 6	18, 9	20, 3	21, 6	22, 9	24, 2	25, 6	26, 9	28, 2	30, 0	31, 6	32, 4	33, 9	35, 2	36, 5	37, 8	39, 2	40, 6
14	17, 4	18, 9	20, 3	21, 8	23, 3	24, 6	25, 9	27, 5	28, 9	30, 4	32, 0	33, 6	34, 8	36, 5	37, 8	39, 0	40, 6	41, 9	43, 6
15	18, 6	20, 2	21, 7	23, 3	24, 9	26, 3	28, 1	29, 4	30, 9	32, 8	34, 3	35, 8	37, 2	38, 8	40, 4	41, 9	43, 4	45, 0	46, 6
16	19, 8	21, 5	23, 1	24, 8	26, 5	28, 1	29, 8	31, 4	33, 0	35, 0	36, 8	38, 4	39, 8	41, 5	43, 0	44, 8	46, 2	47, 9	49, 6
17	21, 2	22, 8	24, 0	26, 3	27, 9	29, 8	31, 2	33, 5	34, 9	37, 1	38, 9	40, 0	42, 4	44, 0	45, 8	47, 3	49, 0	50, 8	52, 6
18	22, 4	24, 1	25, 9	27, 8	29, 9	31, 5	33, 0	35, 4	36, 8	38, 9	41, 2	43, 8	44, 8	46, 5	48, 2	50, 0	51, 8	53, 7	55, 6
19	23, 5	25, 3	26, 9	29, 3	31, 4	33, 2	34, 8	37, 5	38, 7	40, 2	43, 5	45, 7	47, 0	48, 8	50, 6	52, 0	52, 9	55, 5	58, 6
20	24, 6	26, 7	28, 7	30, 8	32, 8	34, 9	36, 9	38, 9	41, 0	42, 1	45, 8	47, 6	49, 4	51, 3	53, 4	55, 4	57, 4	59, 5	61, 6

A Table, shewing the Height and Weight of Iron, Lead, *and* Stone-shot, *accuratly and newly calculated by the Author, and applyed to our assize of English Measure of Inches and Parts, and to the Haberdepoize Weight of* 16 *Ounces to the Pound: With the Description of my Gunners Scale.*

Inches high	Quarters.	Iron pou	Ounces.	Lead pou	Ounces.	Stone pou	Ounces.
1	0	0	0	0	3	0	1¼
1	1	0	0	0	6	0	3
1	2	0	0	0	9	0	4½
1	3	0	0	0	13	0	5¼
2	0	1	1	1	11	0	7
2	1	1	9	2	0	0	9
2	2	2	2	3	0	0	12
2	3	2	14	4	3	1	0
3	0	3	12	5	0	1	4
3	1	4	12	6	9	1	8
3	2	6	1	8	1	2	0
3	3	7	5	9	14	2	7
4	0	8	15	11	5	2	13
4	1	10	10	15	15	3	10
4	2	12	10	17	15	4	3
4	3	14	14	21	5	5	9
5	0	17	5	24	12	6	3
5	1	20	1	30	0	7	8
5	2	23	2	35	10	8	14
5	3	26	6	39	9	10	10
6	0	30	0	45	0	11	4
6	1	34	0	51	0	12	12
6	2	38	0	57	0	14	3
6	3	42	0	63	0	15	12
7	0	48	0	72	0	17	10
7	1	53	0	79	8	19	14
7	2	58	0	87	0	21	12
7	3	64	0	96	0	24	0
8	0	72	10	106	8	26	12
8	1	78	0	117	0	28	8
8	2	87	3	130	8	32	8
8	3	95	0	142	8	35	10
9	0	101	0	150	0	37	10
9	1	109	6	161	8	40	4
9	2	121	10	181	13	44	2
9	3	132	11	198	5	49	8
10	2	138	0	207	0	51	10
10	0	164	2	246	0	0	0
11	0	184	0	275	8	69	8
11	2	216	0	324	0	81	0
12	0	240	0	360	0	90	0
13	0	305	0	457	8	114	8
14	0	389	2	583	8	146	8

THe Vse of this Table in the left margent, is to find out the height of your Shot in the two first Collume of inches, and quarters of inches: Then if is be an Iron shot, ouer against the height so found in the two second Collumes vnder the tytles of *Iron pounds* and *Ounces*, you shall finde the waight thereof. The like may be vnderstood, if the shot be of Leade, by the two third Collumes, or of Sone, by the two last collumes, each vnder his proper title, and ouer against the height assigned. As for example; For, an Iron shot of 8 inches, the weight will apeare to be 72. pound 10 ounces; and if it were of Lead, it would be found 106 pound 8 ounces; but if of Stone, then would it be but 26 pound 12 ounces, which may suffice.

The Description of my Gunners Scale, is to be made in Brasse by M. *Allen: And in Wood, by* M. Nathaniell Gors *of* Ratcliffe.

IT is a square Rule of one foote in length, made eyther of Brasse, Boxe, or other fine grayned Wodde that will not warpe: Vpon one side or square whereof I haue set the height of all sorts of Iron shot, from 1 pound to 100 pound weight: And of Stone shot to 37 pound: And of Lead shot to 150 pound weight: Each distinguished from an other by the Letter *I.* for Iron, *S.* for Sone, and *L.* for Lead shot, and their Weights and Measures accomodated vnto our *English* Haberdepoiz weight of 16 ounces to the pound, and to our Foote of assize of 12 Inches to the Foote. The second side hath twelue Inches of assize, each diuided by Paralells and Dianonall lines, into 100 equall parts, distinctly to take any Number from 1 to 1000, from thence, with a paire of Compasses. The third, hath Sinicall and Logarithmall deuisions, exceeding necessary for the *Gunners* practise, as hereafter shall more plainely appeare. The fourth, hath deuisions proportionall to the right Ranges and Randons of any Peece of Ordinance vpon any Mounture from degree to degree; and the number of Inches that any Peece betweene 6 and 15 foot long requireth to mount her to any degree of mounture, vnder 20 degrees, as well or better then by the Quadrant; as the Table following will also explane.

CHAP.

Chap. XXXII.

Of the rule of Callibres, and of the difference betweene the heights of the Bore and Shot for any Peece, which is called the vent or due abatement to shoote with safety, and most aduantage therewith.

FOrasmuch as it is an excellent quality in a *Gunner* to be expert and ready in the *Heights* and *Calibres* of *Bore* and *Shot* for Ordnance, and to retaine them in memory, rather by reason then by roate, they being the *ground* and *Scale* from which all the *Measures* and *Proportions* for all parts, as well of the *Peece* and her *Cariage*, as of the *Powder*, *Shott*, and *distance*, or the way of the Shot are deriued and vnderstood, as by the precedent & sequent discourses may appeare: But because most *English Gunners* haue hitherto generally as well for the greatest as the smallest, or meane sorts of Ordnance chosen the *Shot* for them all, one quarter of an inch lower then the height of their Bores; which the best experienced *Gunners* of late yeares disliking, haue for a generall proportion chosen rather one twentieth part of the height of the Bore to be abated for a due height of the Shot vent, affirming that in the Faulcon and small peeces the abatement of $\frac{1}{4}$ of an inch is too much, and for the Canon $\frac{1}{4}$ of an inch is too little, and that $\frac{1}{20}$ of the Diametre of the Bore will be a reasonable abatement for all Peeces, be they higher, or lower, which being by Arithmatick so easily found, will not require any example.

Chap. XXXIII.

Of the Gunners, Quadrant, and Triangle, with their Degrees and Poynts, whereby either to Leuell, or else to Mount, or Imbase any Peece of Ordnance, to any degree or poynt assigned.

THe *Gunners Quadrant* is a *Geometricall* Instrument, made of brasse or fine grained wood, containing in the circumference one quarter of a circle, diuided into 90 equall parts or degrees in the outmost limbe, and in the second limbe within into the 12 poynts of the *Gunners quadrant*, hauing within the same also a *Geometricall Quadrate*, with each side diuided into 12 equall parts, and those each of them subdiuided by meanes of

paralels and Dyagenalls into 10 equall parts, ſo that each ſide will be thereby found diſtinctly deuided into 120 equall parts, fitly ſeruing to take all Geometricall Menſurations, of diſtances, heights, breadthes, and depthes, acceſſible and inacceſſible, by the directions hereafter mentioned. The degrees and alſo the poynts being principall helpes for the *Gunners* practiſe, to ſhoote at the moſt certainty both by the right line, and alſo vpon the aduantage of any Randon to and at any Marke aſſigned, to a probable or aſſured good effect; as by the Tables, Scale, and directions following, will more plainly appeare, and by the 21 Figure hereof marked ɔ wherein each Quadrant, (but that which is marked with 4) hath a ſtrait Ruler about 2 foot long, ioyned either firmely, or by a Groue doue-tayled vnto one of the ſides or Semidiametres thereof. Now to plant any Peece leuell, hauing put the ſaid Ruler in cloſe vnto the lower ſide of the Mettall, within the Concaue Cillinder of the Bore thereof, then mount or imbaſe the Peece in her Cariage, vntill the plummet fall directly vpon the other ſide of the Quadrants fiduciall edge, by meanes of drawing out, or putting in the Quoyns as reaſon will direct you: ſo will the Axis of the Bore or Concaue Cillinder thereof, bee found to lye directly leuell, or paralell to the Horizontall plane: you may alſo without a Quadrant leuell any Peece duly founded by holding a plumb line vpright afore the mouth of the Peece, and mounting or imbaſing her by meanes of her Quoynes, vntill the line ſhall appeare only to touch the Flat of the Mettall at the mouth aboue, and below alike: So will the Axis of the Soule that is to cut the flat of her mouth at right Angles, the plumb line being paralell or equi-touching, the ſame flat be found to bee paralell to the plane of the Horizon, or truly leuell as was required: But if by the ſaid Quadrant you would mount the peece to any degree or poynt of the Quadrant, then you are to mount or imbaſe her in her Cariage, by drawing or putting in of her Quoynes more then before ſo much, vntill the plumb line of the Quadrant appeareth freely (the Ruler being put into her mouth as before) to hang directly ouer the degree or point aſſigned. And the like may be ſaid concerning the imbaſing of any peece; as in the 21 Figure *a*, at 2 for the 12 poynts, and at 3 for the 90 degrees *A B C* and *E M N*, And alſo concerning the leuell at 4, to leuell peeces, and to finde the vpper part of the mettall: And laſtly, to mount and imbaſe the peece by the helpe of the plumb line; And by the whole circle at 5, deuided into 48 equall parts, making in each Quadrant thereof the 12 poynts of the Gunners quadrant. The like may be done with the ſight Rule, by the Table hereof.

CHAP. XXXIIII.

Of a new deuiſe by any Staffe, to leuell, mount, and imbaſe any Peece.

ALſo any Peece may with a field *Linſtock*, *Rammer*, or *Spunge*, or other *Staffe* be mounted to any degree of the Quadrant, being thus prepared: Firſt, marke from one end of that Staffe a diſtance, equall vnto the height of the Pomell or Caskabell of the Peece placed

placed leuell vpon her Platforme, and then take the diſtance betweene the Centre of the Trunions and the Pomell or Caskabell, which make or imagine a ſemidiametre of a Circle, and diuide it by Dyagonalls and Paralels, or otherwiſe into 1000 equall parts. Laſtly, out of the Table of *Sines*, take the number anſwering vnto euery degree out of the ſaid 1000 parts, and ſet that diſtance from the ſaid marke downwards. And if the totall *Syne* of the Table be 100000, omit the two laſt figures of each number thereof towards the right hand, and if it be 10000000, then omit foure figures of each number you finde in that Table, and the remaining number will ſhew how many of thoſe 1000 equall parts are to be ſet downwards from the marke beneath the ſaid leuell for each ſeuerall degree: Then drawing alſo 10 Paralels and Dyagonalls from the firſt degree to the ſecond, and from the ſecond to the third, &c. ſucceſſiuely continued from each to his next, noting euery degree with Arithmeticall characters; ſo may you from *6* minutes to *6* minutes by thoſe right ſynes mount the Peece, ſo ſet forth for any Peece which it ſhall be prepared for. This may alſo be deſcribed vpon ſuch a ſtaffe without the Table of ſynes in a mechanicall maner thus: If you deſcribe a Quadrant or Quarter of a circle with a ſemidiametre, equall to the diſtance from the centre of the Trunions, to the centre of the Pomell or Caskabell and deuide the Arch of that quadrant into 90 equall parts or degrees, and then from each degree, letting a right line fall perpendicularly vpon the baſe ſide of the ſaid quadrant. And laſtly, each of thoſe right lines being thence transferred from the ſaid firſt marke downwards vpon the ſaid ſtaffe, and marking them with Arithmeticall figures for each degree, thereupon making alſo Paralels and Diagonalls, as aforeſaid you may thereby Geometrically and mechanically marke the ſame from *6* to *6* minutes as before. The vſe of them are plaine and eaſie, for if you bring downe the centre of the Caskabell or Pomell of the Peece to any number of degrees thereon, ſo marked, for that peece, you ſetting the lower end of the ſtaffe to the Platforme being euen, although it be riſing or deſcending backwards: I ſay then the Axis of the bore of that Peece will be found to be eleuated vnto the degree aſſigned: If you bee to imbaſe the Peece, thoſe lynes and number alſo ſet aboue the firſt named marke, will performe the like office there in the thing required.

Chap. XXXV.

How to finde the right line or right range of any Shot diſcharged out of any Peece, for euery eleuation, by any one Right or dead Range giuen for the Peece aſsigned.

IF the *Range giuen* be the right Range, ſay by the Rule of three if the Tabular number found in the Table of dead Ranges for the degree of the Range giuen, giue the number of knowne meaſures in that Range: what ſhall the Tabular number of the Table of

right Ranges, proper to the degree assigned giue. And hauing multiplied and deuided them duly, the fourth number will be the right Range, or right line for the Peece sought.

Example 1.

SVppose you are to seeke the right Range of 30 degrees for that Peece, whose dead Range for 30 degrees is giuen or knowne to be 2200 paces by it, multiply the Tabular number of right Ranges for 30 degrees, which is 695, and diuide the product by 2150, the Tabular number for 30 degrees in the Table of dead Ranges, and the Quotient will bee 711 paces for the line or right Range of that Peece, mounted and discharged at 30 degrees eleuation.

Example 2.

SVppose the leuell right Range is giuen, and the right Range for 30 degrees mounture bee sought, say, if 192 the first number in the Table of right Ranges, giue 695 the Tabular number thereof for 30 degrees, what shall 197 paces the leuell right Range giuen giue, multiply the third by the second, and deuiding by the first, and the Quotient, will be 713 paces for the right Ranges sought, the difference is that Tables cannot be so exactly calculated, but by omitting small fractions, small differences will grow apparant, by working one question or *example* diuers wayes, which let suffice.

CHAP. XXXVI.

To finde how much of the Horizontall line is contained directly vnder the right line, or right Range of any Shot, made out of any Peece at euery eleuation assigned.

HAuing by the last Chapter found the number of paces, the Peece will carie her Shot in a right line being duly discharged, at any Eleuation assigned, multiply the same by the right Sine of the complement of the degree of Mounture, and deuide the product by the whole Sine, and the Quotient will bee the number of paces (or such like measures) contayned in the leuell, directly vnder the right Range sought.

Example.

BE it propounded how to finde what part of the Horizontall line lyeth, directly vnder the right Range of the Peece assigned at 30 degrees eleuation, the right Range at 30 grades by the precedent, being found to bee 713 paces, and the right sine of 60 grades, the complement of 30 being 866, being

being multiplied together, and the product deuided by 1000, the whole sine leaueth in the Quotient 617, for the number of paces lying directly vnder the right Range sought.

CHAP. XXXVII.

To finde how much of the Horizontall line lyeth vnder the crooked Range of a Shot, made out of any Peece at any Eleuation assigned.

THe *crooked range* is so much as the course or way of the Shot, as it goeth helically betweene the right Range, and the naturall or perpendicular motion, or before it make the first graze; And may bee thus found either by deducting of the leuell distance contained directly vnder the right line or right Range of any Shot made, (found by the last Chapter) out of the dead Range thereof found by the Chapter before-going: For the remainder will be the paces or other measures, lying directly vnder the *crooked range*.

Example 1.

THe Peece supposed to be mounted to 30 degrees, is found to conuey the Shot 2100 paces to the dead range or first graze of the Shot, and it also conuayeth the Shotte 617 paces in the leuell vnder the right Range, which deducted out of the said dead Range, there remaineth 1683 paces, which lyeth directly vnder the *Crooked range*, in the Horizontall line the thing sought.

CHAP. XXXVIII.

Of the violent, crooked, and naturall motion, or course of a Shot discharged out of any Peece of Ordnance assigned.

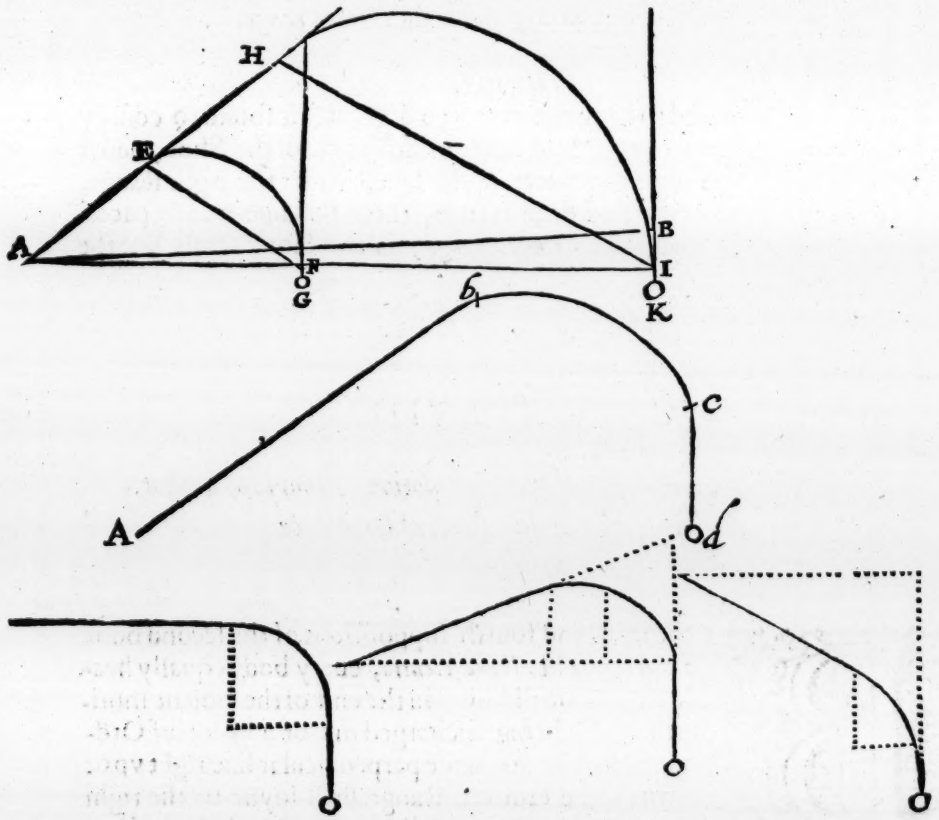
BY the third and fourth suppositions of the second book of *Tartaglia* his *Noua scientia*, euery body equally heauie (as a Globall Shot) in the end of the violent motion thereof, being discharged out of a Peece of Ordnance (so it be not in the perpendicular line right vp or downe) the crooked Range shall ioyne to the right Range, and to the naturall course or Motions, and bee betweene them both: So for example, the right Range being all the line *a b* of the Figure following, and *c d* the naturall motion.

He

He ſaith *B C* will being the mixt or crooked Range ioyne, and bee contingent to them both in the poynts *b* and *c*, wherein *c* will be the furtheſt part of the crooked courſe or range from the Peece ſo directed, and *d* the end of the naturall motion thereof.

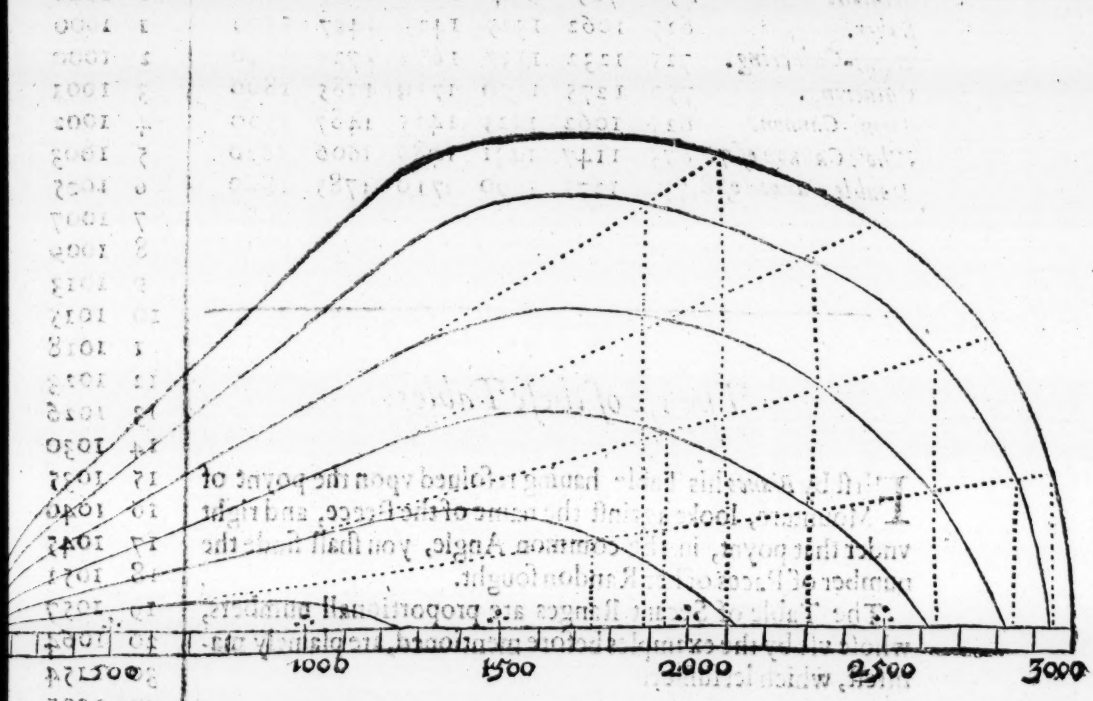
And in his ſeaueuth propoſition of the ſame booke hee prooueth, That euery Shot equally heauy great or little, equally eleuated aboue Horizon, or equally oblique or leuelly directed, are among themſelues like and proportionall in their diſtances, as the Figure following ſheweth: as *A E F* is like and proportionall in the right and crooked Ranges, vnto *A H I*, and in their diſtances or dead Ranges *A F* vnto *A I*.

And in his fourth, fifth, and ſixth propoſitions of the ſame booke, he proueth that euery Shot made vpon the leuell, hath the crooked range thereof equall to the Arch of a Quadrant, or quarter of a Circle; and if it bee made vpon any eleuation aboue the leuell, that then it will make the crooked Range to be more then a Quadrant, and that if it be made imbaſed vnder the leuell, that then the crooked Range thereof will be an Arch leſſe then a Quadrant, as the three laſt figures following doe repreſent.



And

And lastly in his ninth Proposition of the same booke, he vndertaketh to proue, if one Peece be shot off twice, the one leuell and the other at the best of the Randon, that the right Range of the leuell, is but one quarter of the right Range of the best: And that the dead Range of the leuell is but $\frac{1}{10}$ of the dead Range of the best Randon, whereto he that desireth further demonstration, may haue recourse, and examine his demonstrations of those propositions in his said second booke of his *Noua Scientia.* *A Diagram for the Randons of a Saker vpon each of the first six Points, according to Alessandro Bianco.*



Now to finde at what distance from the platforme whereon the Peece is to be discharged, the course of the Bullet will cut the aspect of euery Mounture (which will helpe when a marke shall bee without the right Range of the Peece in the aspect of its eleuation, aboue the Horizon) to make a faire Shot at first by taking a greater aduantage of mounture: as suppose a Marke eleuated 15 degrees, to be distant 700 paces.

By the last Diagram open the Compasses, vntill the aspect cut the poynt of Mounture, then applying the same vnto the scale vnder it, you shall thereby finde at what distance it cutteth the Randon required.

Alexander Bianco *his Table of Randons for the sixe first Poynts reduced.*

	1	2	3	4	5	6
Falconet.	375	637	795	855	892	900
Falcon.	550	935	1166	1254	1309	1320
Minion.	450	765	954	1026	1071	1080
Saker.	625	1062	1325	1425	1487	1500
Demi-Culuering.	725	1232	1537	1653	1725	1740
Culuering.	750	1275	1590	1710	1785	1800
Demi-Cannon.	625	1062	1325	1425	1487	1500
Whole Cannon of 7.	675	1147	1431	1489	1606	1620
Double Cannon of 8.	750	1275	1690	1710	1785	1800

A Table of secant ranges.

0	1000
1	1000
2	1000
3	1001
4	1002
5	1003
6	1005
7	1007
8	1009
9	1013
10	1015
11	1018
12	1023
13	1026
14	1030
15	1035
16	1040
17	1045
18	1051
19	1057
20	1064
30	1154
40	1305
50	1555
60	2000
70	3923
80	5758
90	*Infinite*

The vse of these Tables.

FIrst by *Bianco* his Table, hauing resolued vpon the poynt of Mounture, looke against the name of the Peece, and right vnder that poynt, in the common Angle, you shall finde the number of Paces of her Randon sought.

The Table of Secant Ranges are proportionall numbers, whose vse by the examples before mentioned, are plainely manifest, which let suffice.

CHAP.

Chap. XXXVIII.

How to loade a Peece of Ordnance Gunner-like.

THe Peece being mounted, and duly planted on his Platforme, and well prouided with all things in readineſſe for ſeruice, as of powder, Shot, Ladle, Spunge, Ramer, Wadhooke, Wadds, and Tampions. The Gunner muſt place his Linſtock to Lee-wards, or vnder the winde, and hauing cleared the peece and Touch-hole; he muſt ſpunge his peece very well ſtanding on the right ſide of the peece, and drawing out his Spunge, let him giue it two or three blowes vpon the Mouth on the out-ſide of the peece, to beate off the foulneſſe and duſt it hath gathered within: then his aſsiſtant declining the powder or boudge barrell aſide, he ſhal thruſt in his Ladle to fill it, ſtriking off the heaped powder, giuing a ſhogge to ſhake downe the ſurpluſſe: and it being ſo filled and ſtriked, put in the Ladle downe to the bottome of her Concaue Cillinder vnto the Touch-hole, but at the firſt putting of the Ladle (ſo filled) into the Mouth of the peece, ſlide in the Ladle ſtaffe, ſo that the vpper ſide may keepe vppermoſt all the way, and when it is ariued to the bottome of the Bore, then hee laying his right thumb vpon the ſaid vpper ſide of Ladle ſtaffe, neere the Mouth of the peece, and turning the ſaid ſtaffe ſo much, vntill the ſaid thumb vnremoued vpon the ſtaffe be found directly vnder the ſame; then giuing two or three ſhakes, and bearing vp the Ladle, that the powder may bee turned out, or goe out cleane, and that the Ladle bring no powder back therewith, for that were a foule fault for a profeſſed Gunner to commit. Then ſhall he put the powder home ſoftly, with the Rammer that is at the end of the Ladle ſtaffe; putting in a good Wadd, and thruſt it home to the powder, giuing three or foure hard ſtrokes, which wil gather the ſcattered pouder together, and driue cloſe the ſame, and the reſt to the bottome of the Chamber the Aſsiſtant, hauing a finger vpon the Touch-hole all the whilſt: And then put in the Shot which with a Rammer he muſt put ſoftly home, and afterwards another Wadd of Hay, Graſſe, Weedes, Okham, or ſuch like: And againe, giue two or three good ſtrokes with the Spunges Rammer head: But if the Peece doe require two or three Ladles of powder, it muſt bee all put in before any Wad, in that maner as the firſt was mentioned, and ſo in all other things. And then place the Boudge or powder barrell to wind-wards, and couer it ſafe with ſome Hide, garment, or cloath: alwayes auoyding to ſtand before the mouth of the Peece, but on the right ſide thereof in loading her for feare of further danger. And laſtly, the Peece is to bee layd to the marke and prymed and fired, and ſo will his Peece ſaid to be loaded Gunner-like.

CHAP. XXXIX.

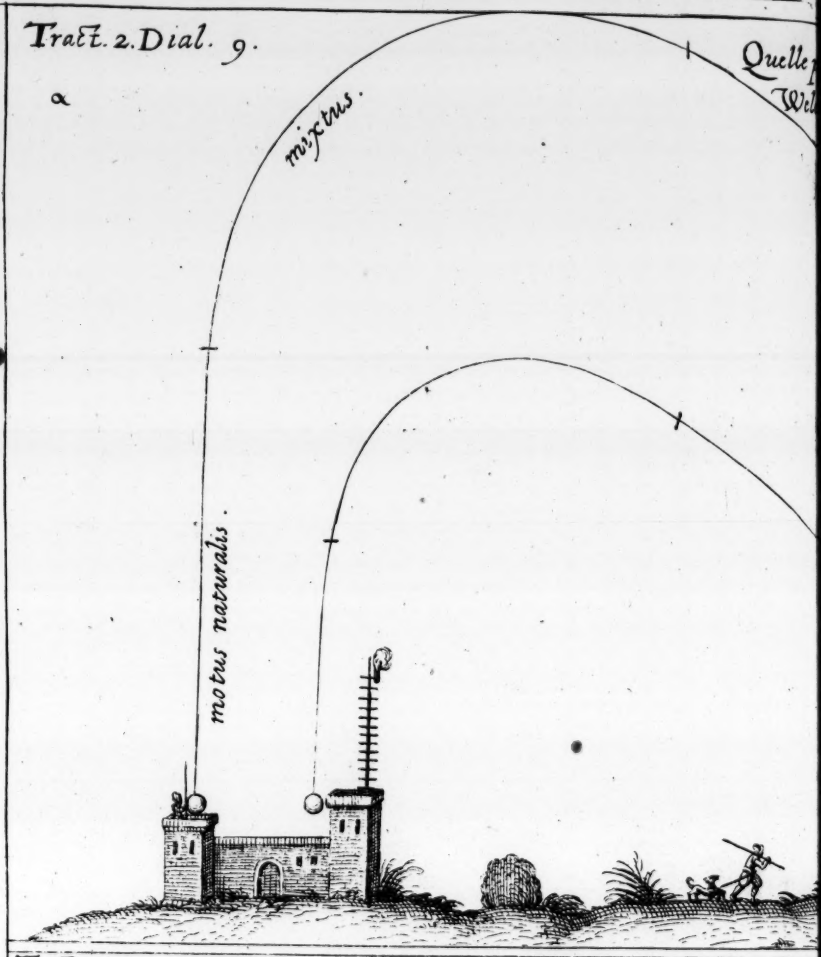
Whether the longer Peeces out-shoote the shorter, and why the Culuerings shoote farther then the Cannon and the Demy-Culuering then the whole Culuerings, &c.

NEuertheleſſe, that the eighth Theorem of this booke affirmeth, that *The longer the Peece the stronger the stroke*, which is moſt true, yet muſt it require this moderation, that all proportions be agreeable in the longer Peeces, namely that the proportion of the height of bore, and fortitude of mettall, and charge of powder, be correſpondent one to the other, as in my Expoſition vpon one of Mr. *Digges* his Queſtions is related: For if the Fortitude of mettall be wanting, and ſo vnable to reſiſt the force of powder due to load your Peece withall, in reſpect of her length & height, ſo that the Shot may be come iuſt to her Mouth in that inſtant, that all the Powder ſhall be perfectly fired, or that by reaſon of her ſhortneſſe (ſhe hauing fortitude) the Shot be gone out before the powder in her be all perfectly fired, there is neither of them both can performe ſo much as they otherwiſe would doe, if their proportions of height, length, and fortitude had beene correſpondent one to another. And there muſt alſo bee a reſpect had vnto the force of the powder vſed, that there may bee a conuenient correſpondencie betweene the proportion of it to the reſt: For otherwiſe, a Peece being loaded with a proportionall Charge of worſer powder, may ſhoote further, then if ſhee were loaded with as much in waight of better powder, by reaſon of the diſproportionalities afore ſaid. It was experienced, as *Luigo Collado* in his 21 *Chapter* mentioneth, that an extraordinary Culuering of 48 Dyametres of her bore in length, being loaded with a Charge of powder vſually allowed to Culuerings (proportioned to the waight of her Shott) did ſhoote fewer paces, then afterwards when 8 dyametres of her length was cut off from her Mouth to her Breech wards. And then alſo 6 dyametres more being likewiſe cut off, and in like ſort, ſhee being loaded and diſcharged at the third time, conuayed her Shot farther then either at the firſt or ſecond, whereby and by the 14 *Theorem* hereof, with the ſaid expoſition, all will moſt plainly appeare both Theorically and Practically: But the olde errour of the Rule of Flat, as ſome Gunners haue called it, and taught it to others: I thought fit to warne you of being a fight Rule, deuided into inches, to ſet on the breech of any Peece, to mount her to any angle vnder 30 degrees, by a like certaine number of inches, and parts, for Peeces of all lengthes, which is not onely impoſſible, but alſo abſurd: As I haue ſhewed before in the 76 Page, where I ſhall ſpeake of the good vſe that may be made of the inch Rule for that purpoſe, with my Table for the ſame in the 93 Page.

BRITISH
16
30
DEC

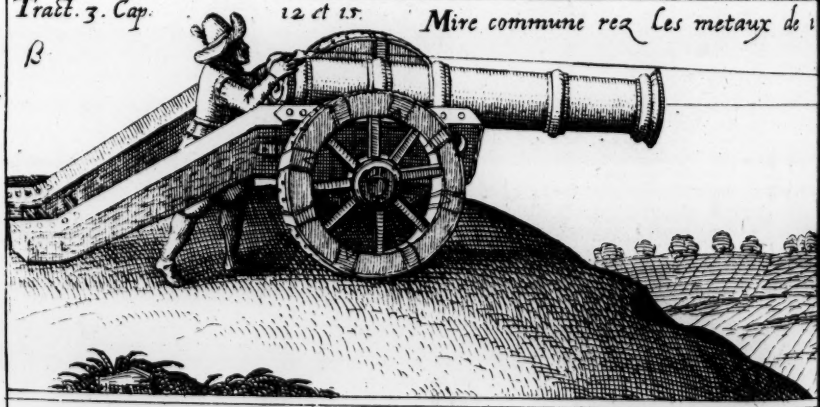
Tract. 2. Dial. 9.

α

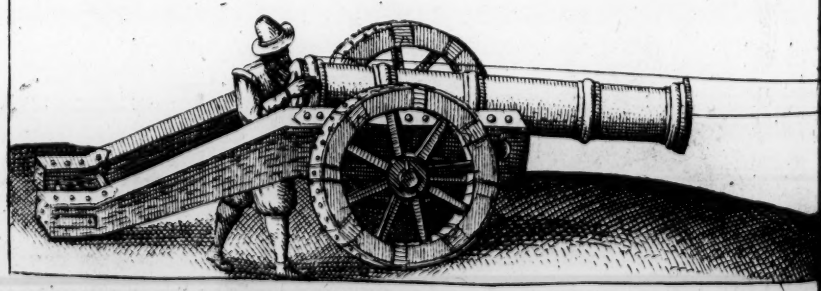


Tract. 3. Cap. 12 et 15. Mire commune rez Ces metaux de

β

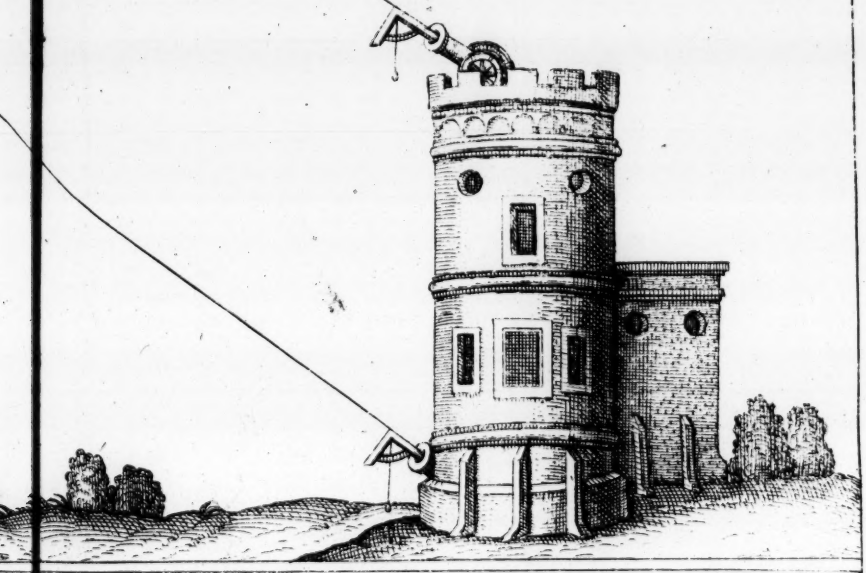


γ Poinct du niueau de l'ame de

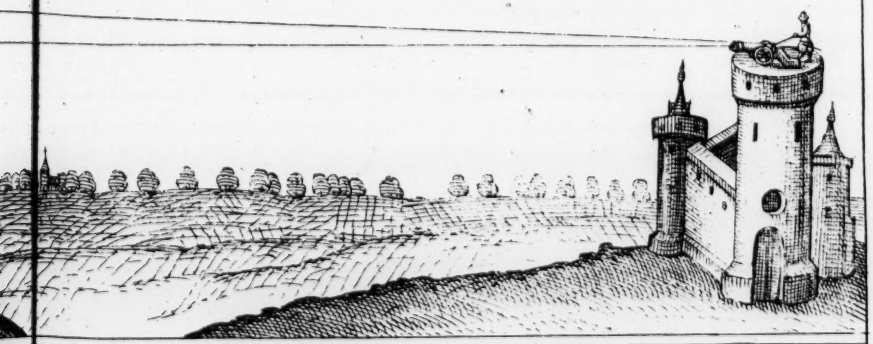


ſrá de plus l'ointaine portee celle du hault ou celle du pied d'vne tour.
Stuck am weitteſten trägt das ſo oben oder das ſo vnden am thurn abgehet

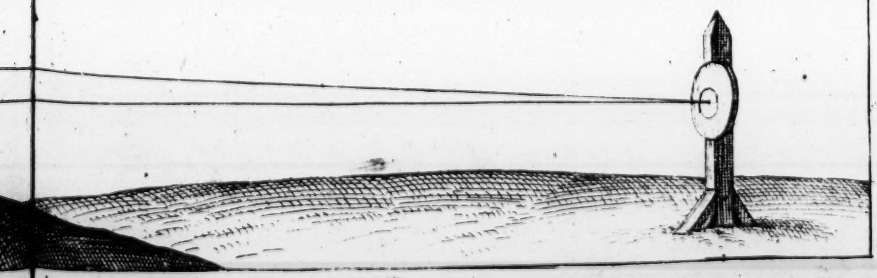
violentus.



de 1000 pas. *Gemeine viſier vber die friſen auff 1000 ſchritt.*



l'ame de 500. pas. *Viſier der wogen auff 500 ſchritt.*



BRITISH MUSEUM
1830
DEC

CHAP. XL.

Of shooting Mira Comune, or by the Mettalls of the Peece, and the difference betweene shooting so, and by the due dispart.

ALthough the difference of making a Shot to a Marke, by the highest of the Mettall at her breech and muzzell, and by the continued aspect of the Axis of her bore, is so vncertaine, according to the length of the Peece, and the differences betweene the Dyameter of the Base and Muzzell Rings, that no certaine proportion can be generally assigned: yet for most Peeces it hath beene well obserued, that the Peece directed by her Mettall, will shoote about twice as farre, when the Marke is leuell, or the sight line being paralell to the Horizon, as it will doe vpon the laying it leuell by the dispart Quadrant or Axis of her Bore, the incertainty thereof depending vpon the Angle, it maketh more or lesse aboue the Horizon, which for each Peece may best be found, by the differences of the disparts of seuerall Peeces that are of equall lengthes, but is accepted or guessed to be generally to shoote twice the distance *Mira Comune*, as it will doe vpon the true leuell Axis: But that Rule is seldome exact, for the difference is sometimes fiue *gr.* and other sometimes seauen degrees, and sometimes neither, euen as the Mounture vpon the Mettall, & the leuell of the Axis will (being precisely examined) make manifest. And therfore to shoote with any Peece *Mira Comune*, or by the Mettalls, the difference or Mount about the leuell, which the mettall causeth being considered, and exactly examined, will shew the Angle of the Peeces Mounture, with which you must repayre to the following Tables of proportionall Mountures, for the seuerall Randons vpon each poynt or degree of the Gunners Quadrant, which is thus easily to to be appropriated vnto any Peece, hauing made one Shotte with her at a Mounture certaine, and finding her proper dead Range for the same, which reuerted to the giuen Eleuation, will soone yeeld the Range required. As for example, suppose that by examination it be found out, that by reason of the ranckues or eminencie of the Muzzle ring, and length of the Chase of the Peece, the direction by the Mettalls at the Breech and Muzzle ring, to mount the Peece higher then it would, if the Azis of her Bore were duly directed by a true dispart, vnto any Marke assigned by sixe degrees, and let it be imagined that the Marke is eleuated sixe *gr.* aboue the Horizon, so found by the Quadrant: And lastly, let it bee giuen at that mounture, the Peece did shoote 850 paces for her dead Range: the question is, how farre the same Peece would conuay the like Shott with like loading and accidents, if she were by the highest of her Mettalls at Breech and Muzzle, directed to the same Marke. Say then if 722, the number in the Table of dead Ranges against sixe *gr.* giue 850 paces, the measure of the Shott made in her at sixe

degrees mounture, what shall 1394 the number against 12 degrees mounture giue, multiplying the third of these three numbers by the second, deuiding the Product by the first, the Quotient 1534 paces, will so much better answere to the question then Mr. *Smithes* rule can doe.

CHAP. XLI.

Of shooting by the Despart or Axis of the Bore (in right bored Peeces, called by some Gunners erroniously the poynt Blanke) as farre as it carreth a Shot in a right line.

THis kinde of shooting called (poynt blanke) is so farre as a marke is within the strait line of the Peece, which for some *Elevations* or Mountures, is much more then for others, for that the more a Peece is mounted, the farther she conuayeth her Shot in the right range, except it could bee shot perpendicularly downwards, which (as I haue already in my first booke called, *The Art of great Artillerie* shewed) may therefore in Peece giuen, yeeld infinite poynt blankes. But bee the Mounture giuen, and the mark within the right line, or right Range of the Bullets course (that is within that space of the Shots right course) as it may be said to goe straite (or insencibly crooked) or so farre as it accompanieth the continued Axis of the Mettal, in right bored Peeces, or of the Soule in the wry bored (which is the cause that in such a Shots there is more seldomer failing, then in any other manner of shooting whatsoeuer) this kinde of shooting being made by the Dispart, so maketh the *errour* to be no more then the distance betweene, the visuall line directed from the middle poynt of the said Axis, and the visuall line that passeth from the Gunners eye, except accidents cause the contrary, it being directed by the highest of the Mettall of the Base ring, and by the top of the dispart vnto the assigned Marke. Now forasmuch as the length of the Peece and the variety of the Powder by the eighth *Theorem*, breedeth the difference of force, swiftnesse, and vehemencie of the Short and stroke of the Bullet: it is therefore impossible to giue generall certaine Rules for the right Ranges, without some experience in that Peece bee first made, found thus.

If many Papers or Cloathes be set in the right line or way of the Shotte, betweene the Mouth of the Peece and the Marke, then making an orderly shott with a full Bullet directed to some Marke, setting a sticke in each place, with the top thereof right in the Centre of the hole which the shott went through at euery paper: You shall thereby perceiue where the shott did first begin to decline, and how much at each distance, which being measured, will very much informe the *Gunner* both for leuell Batteries, and shooting

ſhooting at randon, and vpon aduantage, in the meane ſpace the Table following will for right ranges helpe.

A Table of the proportions of right Ranges, or poynt blanks.

0	192
1	209
2	227
3	244
4	261
5	278
6	285
7	302
8	320
9	337
10	354
20	424
30	693
40	855
50	1000
60	1140
70	1220
80	1300
90	1350

The vſe of the Table, with example.

Hauing foundby experience that at 6 degrees of Mounture the Peece aſſigned Shot 200 paces in a right, or inſencible crooked line, and would know how farre the ſame Peece will ſhoote in a ſtraite line, being mounted to 10 degrees, ſay by the Table, if 278 the number, againſt 6 *gr.* giueth 200 paces, what will 354 the number therein againſt 10 degrees giue, 278 paces.

CHAP. XLII.

Of ſhooting vpon the Aduantage or Randome at a Marke, beyond the right line of the Peeces reach, or right Range of the Shot: and of the dead Range for any Peece at euery degree.

AS in the laſt Chapter wee haue ſaide for the right Range, ſo muſt we alſo ſay for the dead Range, which conſiſteth of the addition of the right and crooked Ranges together into one, and then called the dead Range, which is the whole diſtance from the Platforme, vpon which the Peece aſſigned is diſcharged, vnto the firſt fall or graze of the Bullet, vpon the leuell line, or Horizontall Plane, by reaſon the diffe-

rent lengthes of the Peeces, and ſtrength of the powder encreaſeth or deuinceth the courſe or fury of the Shot, and therefore more difficult to bee found, but only by experience, or by Diagrams, Tables, or Scales made from experiments.

experiments. Now although it bee very difficult, and a thing vncertaine alſo, to ariue herein to exactneſſe, without ſome experiments made with the aſſigned Peece and Powder: Yet to come to a neceſſary neereneſſe at firſt (farre ſurer then by vncertaine gueſſing) either by the Table here annexed by my Scale or Rule, grounded vpon often obſeruations and tryall, I hauing made 200 ſhott for it, you hauing the right range for the Mounture aſſigned by the former dead Range, of the Shott for the Mounture required. Note where the Shots courſe cutteth the Angle of euery Mounture, for that Peece and powder giuen in this manner: Firſt, take the right Range of the Peece experimented from the right Range for the Mounture aſſigned, and diuide the remainder in ſuch reaſon, as the ſaid Angle of Mounture is to the Angle of the complement thereof, and to the Quotient adde the ſaid right Range found, and the off come thereof, will bee the dead Range for that Peece, Powder, and Mounture aſſigned. As for example, let it be ſuppoſed, that a Peece mounted at 30 degrees, ſhot 300 paces in the right Range, and 3000 at the dead Range, I deſire to know the dead Range at 40 degrees.

A Table of the proportions of dead Ranges.

Gr.	Pa.
0	192
1	298
2	404
3	510
4	610
5	722
6	828
7	934
8	1044
6	1129
10	1214
11	1396
12	1394
13	1469
14	1544
15	1622
16	1686
17	1744
18	1792
19	1849
20	1917
25	2013
30	2185
35	2249
40	2289
42½	2296
45	2289
52½	2283
60	1792
67½	1214
75	1000
85½	192
90	0

To doe this the plaineſt mechanicall way, is to diuide that dead Range into any number of parts at pleaſure, which ſet out in a line, at one end of that right line, make an angle by the 23 propoſitiõ of the 1 of *Euclide* demonſtrated herein, and from the other end thereof erect a perpendicular line by the 11 propoſition alſo there mentioned, vntil it interſect the line that framed the Angle giuen, and note well how many ſuch parts it containeth, and multiply the parts of the dead Range by the parts, that the line that framed the Angle containeth, and then diuide the product by the number of parts you diuided the line of the dead Range into, and the Quotient will bee the Secant Range, which knowne, (as imagine, for the ſecant Range was found 1555 paces, and for the dead range 2000 paces giuen) Say if 1555 giue 1000 the whole *ſine*, what ſhall 1000 the dead range giue, 643 $\frac{1}{7}$, the right ſigne of the Angle, the Peece muſt be mounted vnto, vpon the aduantage, to ſhoote 1000 paces for her dead range.

CAP.

CHAP. XLIII.

How to order and direct a Peece, and amend an ill Shott that was made either by the Mettall, leuell, right line, or aduantage, or Mount.

IF leaſure will not permit to vſe the Ruler and Beuill, then the Gunner may by his iudgement, according to the Charge and proportion of the Peece, take ſuch a marke as he gueſſeth neereſt, and likeſt to be beſt for the purpoſe; if it prooue to ſtrike on't iuſt, then hee hath his deſire: for vſing like Powder, Shott, and hauing like temper and accidents, he ſhall alwayes make thereby the like Shot. But if the Shott went too high, hee ſhall then direct the peece in like ſort againe, and lay ſome ſmall thing, as diſcretion will guide him vpon the higheſt of the muzzle ring, and bring it and the higheſt of the Baſe ring in one, with the firſt point or marke, doing ſo, or more or leſſe vntill he hit the marke deſired, and the ſame may be tryed by bringing the peece vpon the firſt marke, which without doubt hee ſhall attaine vnto with reaſons Rule as afore. And if the firſt Shott be vnder or ſhort, he muſt doe as before ordering and directing his peece in like manner, ſauing that before the peece be remoued, hee muſt lay ſome little thing on the higheſt part of the mettall at the breech, and then by helpe of the Quoynes, ſhee being imbaſed or mounted more or leſſe, as occaſion requireth, vntill the higheſt of the mettall at the Mouth and Breech with that helpe, and the firſt marke become together into one right line. And ſo is the peece ordered for the ſhooting by *Mira Commune*, vnleſſe fault bee by loading of the powder too much or too little, &c. And although other accidents may miſleade him therein, yet either of thoſe faylings are alſo to bee reformed by the Beuell Quadrant repreſented in the 25 figure. As if the Gunner by the mettall take his marke ſo, that the Shot fall ſhort: To correct the ſame, after the peece at the next Shott, is placed as before, hee may then by the ſaid Beuell quadrant eleuate her one degree or poynt higher: As if ſhee were formerly at ſixe poynts or degrees, ſhee may now be ſet at 7, and then giuing fire, if it ſtrike the marke, hee may alwayes order it in the ſame manner afterwards. But if it were too high, little, or much, hee muſt accordingly diuide that difference betweene the ſixth and ſeauenth poynt or degrees by diſcretion (by the lighting of the laſt Shot.) And if it were too low, then proceeding in the ſame manner, to adde to the ſixth poynt, with iudgement: and ſo may aſſure himſelfe hee may be like to get reputation thereby. But if he be to order a peece to ſhoote by the leuell of the *Soule*, or Axis of the *Bore* horizontally, then place a peece of boord, within or vpon the bottome of the bore at the muzzle, as in the precedent *Chapter* betweene the ſaid long Ruler and Beuell Quadrant, raiſing or imbaſing her with Handſpeeks and Quoynes, vntill the plumb line of the ſaid

Beuill, hang directly in the midſt thereof: So will the Soule or Axis of the Bore lye directly leuell or paralell with the Horizon. Then taking away the Ruler and Beuill, and taking by the higheſt of the mettall at the breech and muzzle, direction to lay her right, and to what marke they reſpect for height; note that for after vſes, and giuing then fire, he may attaine therein his deſire.

Foraſmuch as opportunity will not alwayes permit to place the ſame on the Mouth as aforeſaid. The Gunner may keepe that thickneſſe or diſpart in his hands, and take his leuell by the mettall as the faſhion is, vntill thereby he diſcerne the marke, and them both to bee in one right viſuall line. And then ſetting on the diſpart vpon the muzzle ring duly, and bringing downe the mouth of the peece vntill the ſaid marke, and the top of the diſpart, and the higheſt of the mettall at the Breech become all three in one right viſuall line: then take off the ſaid diſpart, and note what marke will then bee in one right line, with the midſt or higheſt of the mettall at the breech & muzzle, which will be much vnder the firſt marke, and it will ſo ſerue euer after to make a ſhott, to an aſſured good effect at the ſame marke, and with the ſame peece, from the ſame plat-forme.

The like is to be done in ſhooting at a marke, eleuated to any degree about the leuell: As alſo for ſuch marks as are beyond the diſtance of the right line or right range, by allowing an addition of a Minute, Degree, or Poynt of eleuation, for aduantage more or leſſe, as need ſhall be, vntill the Shot hit right, and as reaſon will direct. As for example, a Saker is to ſhoote at a marke eleuated vnto 15 degrees, it being diſtant from the plat-forme 1325 Geometricall paces 5 feete to the pace. But being mounted to the ſecond poynt, or 15 degrees, ſhe will ſhoote but 1062 paces in her dead range, and in her beſt Randon ſhe will conuay a ſhott but 600 paces, in a right line, wherefore it being almoſt 300 paces ſhort of the dead range for 15 degrees, and aboue 700 paces ſhort of her right range vpon her beſt Randon, I muſt by my Gunners Scale, or by the Diagram of Randons in the 27 precedent Chapter, by the perpendicular raiſed from the Baſe at 1325 paces, finde what randon croſſeth the aſpect of the ſecond point, which will be thereby found to be the fifth points Randon. If then I ſhall mount the ſaid Saker vnto the fifth poynt: ſo then I may expect her ſaid Randon, to ſtrike or come neere to that marke, that ſhall be eleuated to the aſpect of the ſecond poynt, or 15 degrees, at the diſtance of 1325 paces, and ſo after 2 or 3 ſhotts at that aduantage attaine my deſire.

This is the ordinary manner of ſhooting vpon aduantage of any Mounture whatſoeuer, alwayes obſeruing the meanes how to draw as neere the Enemie as can be. In generall, you may obſerue, that in taking ayme by the higheſt of the mettall, without conſideration of the diſparture, if the viſuall line thereof aſpect the marke, the ſhott will bee alwayes too high within the right range, contrary to the Gunners diſeigne, which ſhould be to ruinate the Foote of the defence in Batteries the ſooner to ouerthrow the wall, alſo to facillate the entery of the Breach, but ſingly to ſhoote at a Troope of Horſe or Squadron of Foote, and eſpecially in grauelly or ſtony places it were not amiſſe purpoſely to ſhoote ſhort to light vpon the ſtones, to beate them ſo vp, as that the rayſing of the grauel and ſtones may do the more execution

cution, entering trauerse-wise amongst the Enemie. But in a plaine or leuell Champion, and amongst Battalions of men the Peece should be so bended and directed, as that her shot may passe by the midst or thickest of them, guirdle height: and so it may cut off a hundred, or whole Ranke or File of Men at once, and breake their Orders and Rankes, whereby those that fall on their Faces will hardly escape, but shooting ouer, profiteth nothing at all, but is meerely lost.

To amend a wide shot, if it went too much towards the right hand, then remoue the dispart, or take the large of your sight line somewhat more towards the left hand at the muzzle ring, keeping the former height, or letting the Dispart stand as before, and take your marke as before, onely remooue your eye a little more towards the right hand vpon the Base ring: And so likewise doe contrariwise, if the fault of the shott aforesaid went too much towards the left hand: and so you shall assuredly amend the former shooting, vnlesse some of these ouer-ruling causes or accidents cause the contrary, namely her Soule or Concaue bore, not being straite and right, or lying a wry in the body of the mettall, for then the fault is not in the *Gunner*, but in the *Gunne*, which hee must with iudgement and good discretion rectifie, as hath bene already shewed in the 44. *Chapter* hereof. She will shoot wide also if the *Trunions* lye not directly the one against the other: as also if the plat-forme lye awry one side higher then the other: or if the *Gunner* take not his ayme, so that the vituall line that passeth from his eye to the marke: or if one wheele be higher then the other, or if one wheele be stiffe and the other iocond, or be squatted with any rub in the reuerse of the Peece, or run vpon soft, and the other vpon hard ground: or if the Cariage-maker haue made the Cariage leane, or hang more vpon one, then the other side: If the Naue be too wide, that the Peece shake therby in her discharge, and reuerse: or if the tayle of the Cariage rest harder on the plat-forme vpon one side more then on the other, when the shott is too lowe for the Peece, and at the deliuery toucheth vpō one side. And lastly the vehemency of the wind being sidewise, ouer-rules it to the contrary-side-ward, &c. But if the Shot fall to short or too farre, that happeneth by the force or feeblenesse of the Powder, or vnskilfulnesse of the *Gunner*, not directing his peece as he ought, or in ignorance, or by mistaking the distance to the marke he would shoote at.

Chap. XLIIII.

How the Gunner may be assured to make a good Shott.

Sometimes the occasions offer to require, that the Peece be curiously directed, and precisely bended to dismount a Peece of the *Enemies* that galleth shrewdly, or at a single mark, or at the Loope, Tronier, Cassamat, Horseman, Boat, or other secret place assigned, that else would impeach the appointed seruice and deseigne: For which the *Gunner*

ought to haue an entire and perfect knowledge of the condition and quality of his Peece, by experience made by former practiſes in her, otherwiſe it wil be vncertaine and vnlikely, that he at the firſt ſhot, out of a Peece, wherein they neuer practized, to make an aſſured good ſhott: and then in loading her, to haue great care ſo to put home the Powder, Shott, and Wadd, as that the powder may fire at once, that the Peece reuerſe not vnrulily, it being a certaine thing, that the more ſlowe the powder is in firing within the Peece, the greater will her reuerſe be, and the ſhott alſo of the leſſe force in execution. And likewiſe the reaſonable putting home of the Shott and Wadds, neither too hard nor too eaſie, but that the Ball may gently with a conuenient vent, onely enter in cloſe vnto the Powder-wadd. And laſtly, hee may direct his Peece by the Quadrant Beuill inch-rule, or other former directions, taking his ayme directly by the higheſt of the Mettall vnto the aſſigned mark, or with a due diſpart placed vpon the poynt of the muzzle ring, which higheſt parts may there and at the Baſe ring alſo, with a ſmall line be noted for the viſuall line to paſſe vertically ouer them: And then giuing fire, let him not doubt of an aſſured good effect, hauing a diligent hand in preuenting the accidents that are to be prouided for, as in the 43 *Chapter* hereof are mentioned, to auoyd ſide, ouer, or vnder ſhooting, and conſidering well that ſuch a good ſhott made, gaineth the *Gunner* much loue and honour. The fitteſt Peeces for that purpoſe, are either the *Culuering*, *Demy-Culuering*, and *Saker*, or the *Cannon*, *Demi-Cannon*, and *Minion*.

Such a Shott ought to be made knowne to the *Generall* of the Army, who ſhould therefore liberally reward the *Gunner* that made the ſame, not onely to encourage him, but others alſo, afterwards to doe the like, or better if it were poſſible. *Lewis Collado* in his *Manuall Practiſe of Artillery*, writeth, that at the Siege of *Siena* there was a Peece lodged vpon the great Church, from which the beſieging Army receiued much domage: but in the end a Germaine Gunner made a ſhott thereat, who at the firſt did not onely diſmount the ſame Peece, but alſo made the *Gunner* thereof, and thoſe that were about him, flye together in the ayre to their deſtruction: the which *Marquis de Martinian*, the Generall of the Army ſeeing, it pleaſed him to take a Chayne of gold from his owne necke, and to giue it vnto the *Gunner* that made the ſhot, for his reward, which did not only reioyce him, but encouraged all the reſt of the Gunners to endeuour diligently, ſo to purchaſe the like honour and reward, when like occaſions were preſented.

CHAP. XLV.

How to make Ladles and Spunges for euery ſort of Ordnance.

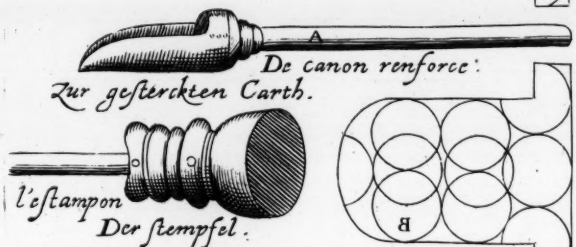
IT were very requiſite that the *Gunner* himſelfe ſhould know how to trace, and cut out, and alſo make vp, and finiſh, all manner of Ladles, to loade Ordnance with, either when neede ſhall require, to prepare them himſelfe, or at the leaſt to direct others how they ſhould bee proportioned and wrought,

16
30
DEC

α

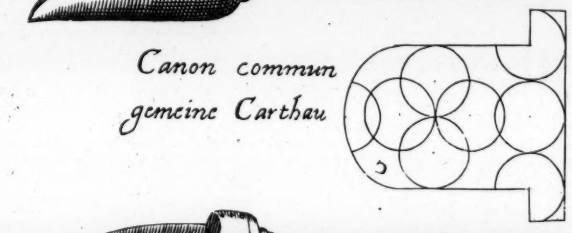
De demij can. ronforce
Zur halben gesterckten Carth.

De canon renforce:
Zur gesterckten Carth.

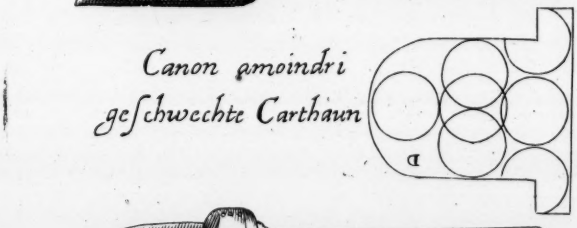


l'estampon
Der stempfel.

Canon commun
gemeine Carthau



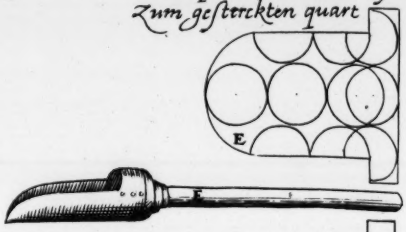
Canon amoindri
geschwechte Carthaun



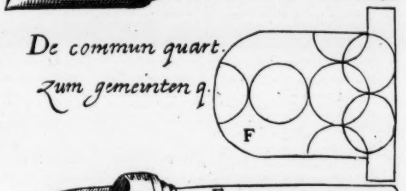
lanade

La mesure et proportion des cuieilliers a charger.
Maß vndt proportion der ladtschauffelen.

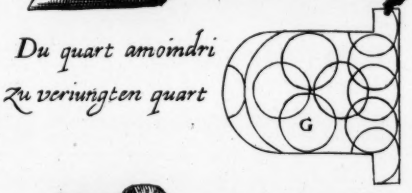
De quart de Canon renforce
Zum gesterckten quart



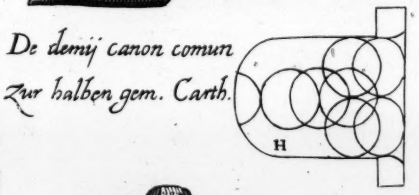
De commun quart.
Zum gemeinten q.



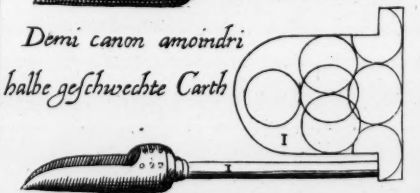
Du quart amoindri
Zu veriungten quart

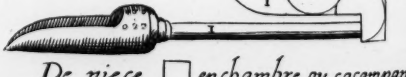


De demij canon comun
Zur halben gem. Carth.

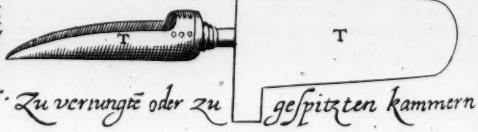


Demi canon amoindri
halbe geschwechte Carth





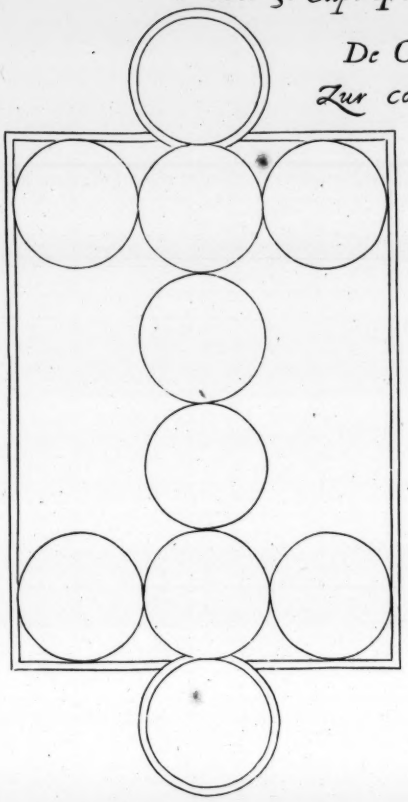
De piece enchambre ou cacampane



Zu veriungē oder zu gespitzten kammern.

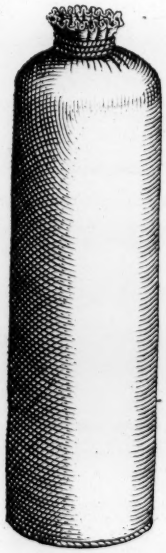
β

De Colubrine
Zur colubrinen.

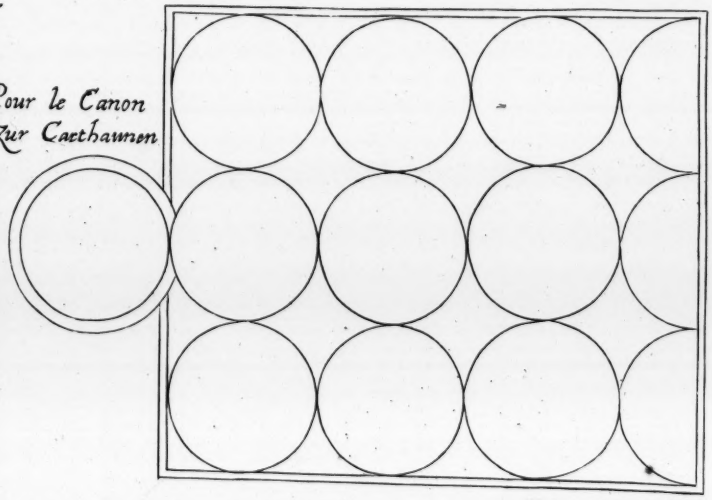


La mesure de sachetz ou cartuches, desquels on sert pour charger vne piece au default de sa propre cueillier.

Form vnd maß der secklein oder patrohnen so in mangel der rechten ladtschauffeln gebraucht werden.



Pour le Canon
Zur Caethaunen



as alſo, that he may be the better able out of the Magazin or ſtore, to make choyſe of ſuch as ſhall duly fit thoſe Peeces that are vnder his Charge and Command: For as it is a dangerous thing, or a great ſhew of ignorance to miſtake one ſort of Shott for another, which may ſoone happen, if he know not how to examine or Calibre them: ſo it is not onely ſhamefull, but dangerous alſo for a Gunner, to imploy an improper Ladle, vnleſſe vpon neceſſity, and then alſo with great care and iudgement, being either too long, too ſhort, too lowe, or too high for the Peece, for being too high, it will not enter, too low, it will not fill, but ſpill, and too long ouer, and too ſhort vndercharge, each of which ſhould bee accounted for an abſurd fault. Wherefore I aduiſe euery Gunner to be very vigilant and carefull, that hee commit not that errour, but rather to be induſtrious, not only to learne how to make his Ladles and Spunges himſelfe, but alſo to bee able to direct and ſhew others, how they ought to be ſeuerally proportioned, made & diſtinguiſhed; as followeth.

For double fortified *Cannons*, to charge them with two Ladle-fulls, they are to be two dyametres and a halfe of their Shott in length from the head of the Ladle-ſtaffe, which ſhall be one dyamere more of plate, which muſt goe about the ſaid head: The Braſſe plate muſt be in breadth two dyametres vnto the ſaid head where each ſide muſt haue halfe a dyametre more, to encloſe the head of the Ladle-ſtaffe within the plate.

The Button or head of the Ladle-ſtaffe muſt be one dyametre, and of ſuch height or thickneſſe, that it together with Braſſe plate may bee equall to the height of the Shott (due vent being abated) for Spunges, their buttons or heads are to be made of ſoft faſt wood, as Aſpe, Birch, Willow, or ſuch like, and to be one dyametre, and ½ in length, & not aboue ⅔ of a dyametre of the ſhots height: The reſt being couered with rough Sheepes skinne wooll, and all, be nayled thereon with Copper nayles, ſo that together they may fill the Soule or Cauity of the Peece.

The Button or head of the *Rammer*, muſt be turned of hard wood in length 1 dyametre, and ⅓ of ſuch height or thickneſſe, that it may fitly enter into the Peece the ſhots vent allowed: it were the better for faſhion & ſtrength: if the ⅓ next the ſtaffe were handſomly turned with abatement, and a Ferrill, or Circle of Braſſe fitted thereupon, to ſaue the Head from cleauing, when as with force we ſhall ramme the Shott home. All theſe Heads or Buttons muſt be pierced ⅔, with a hole for the ſtaffe an inch or more dyametre, wherinto the ſtaffe muſt be faſtned: and the ſtaffe muſt euer be ſo long, that it muſt be at the leaſt one foote longer then the Cauity or Soule is deepe.

For the ordinary *Canon*, the Ladle muſt be of the ſame bredth, but muſt not ſurpaſſe 2½ dyametres of the ſhott in length: and for the leſſened *Cannons* two dyametre onely to loade at twice, all according to the faſhion, length, and breadth, as is ſhewed in the 20 figure *e*, with the manner of faſtning them vpon the ſtaues; wherein alſo the faſhions as well of the Heads or Buttons, as of the Ladles and Rammers, are ſo repreſented to the eye, that the diſcreete *Gunner* ſhall neede no other inſtruction therein: Where the deſcription for the *Demy-Cannons*, which are of the ſame meaſures and proportion as afore-ſaid are theſe, hauing reſpect to their owne proper Bores.

The Ladle for *Culuerings* and *Demy-Culuerings*, haue foure dyametres of

their proper Shots in length, and two in breadth.

The Sakers, Faulcons, & Falconets, which may with one Ladle ful be load at once, may haue their Ladles of 7 dyametres, & ½ dyametre of their Shots in length, beſides that Couerture of the Head of the ſtaffe: and of breadth 2, as all the reſt haue.

For *Periers*, which vſually haue Chambers, with ore-loes ½ or ⅓ leſſe in bore, then their Chaſe containeth, to them 3 times the dyametre of their Chamber may be allowed for length of their *Ladles*.

Now if it ſhould chance you were (hauing no Ladles nor Ballance ready) commanded to loade a *Cannon*, or any other Peece in haſte: Firſt, put the rammer into the Peece vp to the *Touch-hole*, and marke, the ſtaffe, euen with the mettle at the mouth of the Peece, and then pull it out 3 dyametres, for the Cannon, and 3 ½ for the *Culuering*, and 4 for the Saker Falcon, &c. and marke there another marke, which is the place that the Powder muſt ſupply in the Chamber: And then take Paper, Parchment, or Cloath, as long as the diſtance betweene the two markes wrapped round, being of height equall to the bore of the Peece, ⅒ leſſe, faſten the ſame with mouth glew, or ſow the ſides and bottom, and fill the ſame with powder, and powre it into the Peece, putting it gently home, doe ſo vntill you ſee the laſt made marke, to be equall to the flat of the mouth, the Rammer head being home vnto the Powder, then put in your Wadd and Shott, as elſe-where is taught.

CHAP. XLVI.

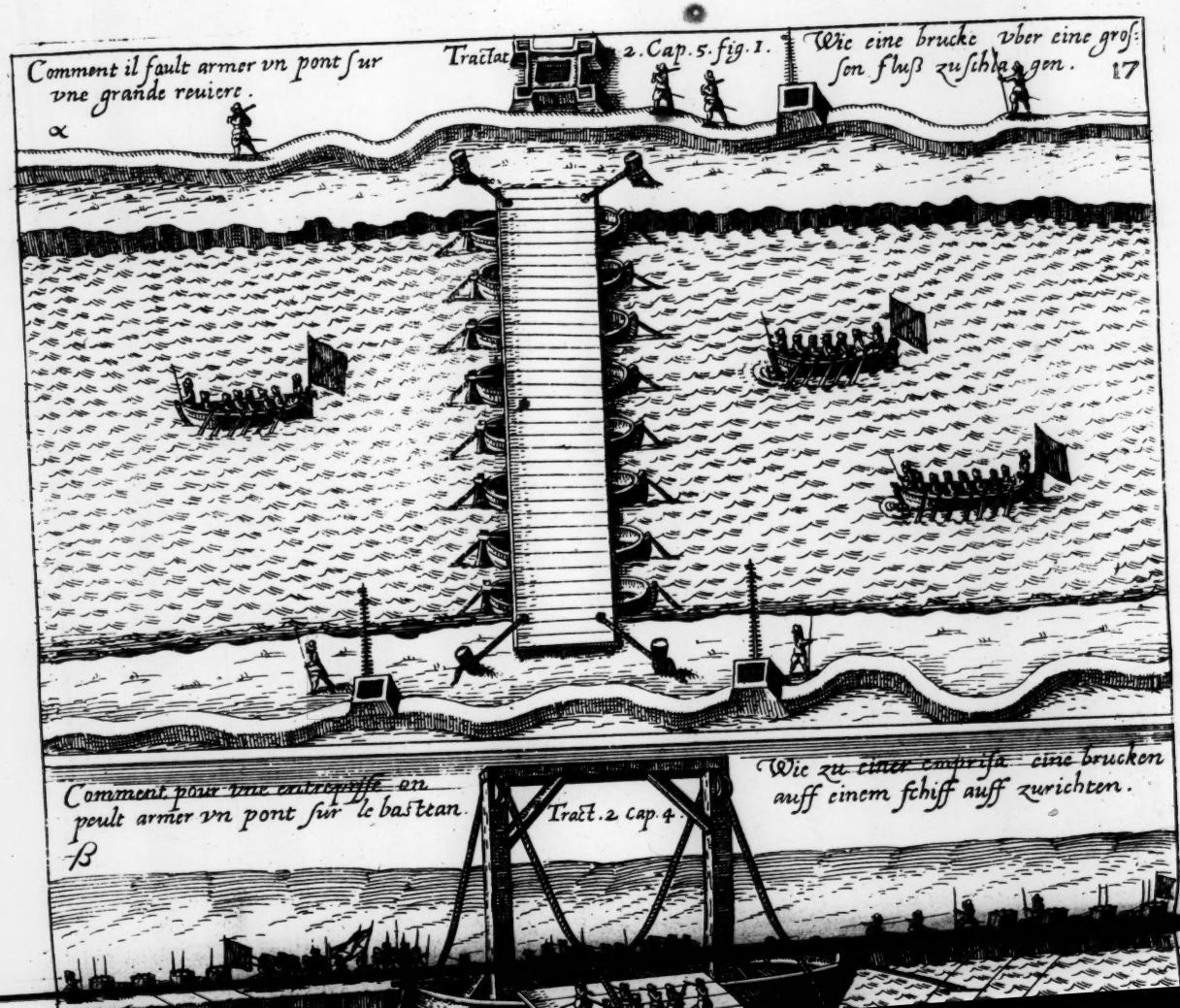
How to make Bridges ouer great or ſmall Riuers, to paſſe an Armie with the Ordnance, and other Cariages ouer the ſame.

OFten times it ſo happeneth, that paſſages are ſtopped, and not to be recouered, eſpecially about Riuers for want of Bridges, or elſe ſome Marriſh or Mooriſh place interpoſeth: Wherefore to bee prepared in all Accidents, eſpecially to paſſe the Ordnance ouer a Riuer, that one Bridge or Moore may be ſpeedily made, either with Boats placed 12 or 14 foote aſunder, and moored by Ankors faſt a head and a ſterne, eſpecially where the Riuer ebbeth and floweth, elſe if they be but faſt a head, it may ſerue they muſt at ſuch diſtance be layd in a right line, to ride croſſe the whole breadth of the Riuer, at the place appointed. And then betweene each two next Boats, place 3 beames of Timber, being 18 foote in length, whereof 14 foot muſt be to reare betweene the 2 next Boats at each end, two foot muſt be to beare vpon the Boate, which Boats muſt be of euen height or nigh, and the Beames are to be layd 6 or 7 foote wide, each from other, that the bridge may be 10 or 12 foote broade, as well to conuay ouer the Horſe and Foote

as

16
50
DEC

La facon d'un pont legier couuert
de Voyle aux costez
V
Tract. 2. Cap. 5. fig. 4.
Eine leichte brucke
nebon her mitt lei:
nen duch bedecket.


Comment il fault armer vn pont ſur vne grande reuiere.
Tractat 2. Cap. 5. fig. 1.
Wie eine brucke vber eine groſſe ſon fluß zuſchlagen. 17
α
Comment pour vne entrepriſſe on peult armer vn pont ſur le baſtean.
Tract. 2 cap. 4.
Wie zu einer empriſa eine brucken auff einem ſchiff auff zurichten.
β

as the Ordnance, Cariages, and all other neceſſaries belonging to the Armie, for the ſurety and ſtrength of which, there muſt vpon euery Boate be alſo three other peeces of Timber of ſuch length, that it may at each end reach 3 foote ouer the Boates ſide, vnto which the three Beames aforeſaid, muſt be faſt pinned with Tree-nayles and yron bolts, with forelockes and keyes, to make them faſt one to another. Theſe Beames and Timbers are to be couered ouer with Planks two inches thick, or one inch and a halfe at leaſt, and 17 or 18 foote in length, the deſcription of which may be ſeene in the 17 figure at *α*.

But if any boggy or muddy ſpace be betweene the Riuer and the fixed ground, ſo that the Ordnance cannot be brought nor drawne neere enough vnto the Bridge, then that part muſt be filled vp with ſuch things as are fitteſt to make it firme, whether it be with Faggots and Earth, or Chalke or ſtones, pyling the ſides with Timber driuen in, vntill they reach into firme ground at the bottome for foundation, and to reueſt it then with boords or walls, according to the time intended, it ſhall laſt and continue, that thereby the way may be firme land and euen. But if any doubt be that the Enemie will ſuppriſe this Bridge, to make himſelfe Maſter of the Riuer then at each end thereof, a halfe Moone, or Reddout, or Fort, with Ordinance to doe murther, and fire-works muſt be prepared to preuent him, and therein beſides the ſide of the Bridge, may bee paliſſadoed with long ſtrong ſharpe poynted ſparrs faſtned, thereto to ſecure it that way. Alſo a continuall and a carefull eye muſt be caſt vpon euery part of the Bridge, that if any accident of defect be in any place, it may be ſpeedily repayred and amended: and a Rayle on ech ſide would be needfull for a ſtay. A Bridge alſo may in like manner be made with Truncks, as is repreſented in the ſaid Figure at *β* And alſo to be linkt vpon one great veſſell, with a falling defenſiue poynted palliſado, as therein likewiſe at 4, is repreſented, and vpon Cask, Cables, &c. which I omit, being rather proper vnderſtandings for the *Enginier*.

CHAP. XLVII.

How to defend a Fortreſſe beſieged, and the order, and what prouiſions of Amunition will be neceſſary for the defence thereof.

A Fortreſſe beſieged being well defended, may returne to enioy her former liberties, which the better to doe, it will be neceſſary to make plaine, cut downe, and ruine whatſoeuer ſhall be hiding and hurtfull, within halfe a mile or more round about the Fort, be they Bankes, hollow wayes, Hedges and Dykes, of Lanes, Buſhes, Trees, Houſes, Mills, Gardens, Conduits, and ſuch like obſtacles, as not onely hide them, but hurt you alſo. Next looke that the Place bee well victualed, according to the number, for man and beaſt, fitting for defence, and neceſſary vſe thereof ſixe moneths, which

which is the longeſt time a Fort can be like to hold out, without ſuccour or ſupply from abroad. Alſo Amunition muſt not be wanting, at leaſt ſo much as may furniſh the Flankers and Artillery, which muſt be as ſafe and couertly placed as may be, and not to be eaſily choaked or diſmounted. For Amunitions, preciſe proportions cannot be preſcribed, becauſe each day miniſtreth new neceſſities, and as the Enemy abroad raiſeth or maketh new workes. Within Men and Munition may be reaſonably paralelled with $\frac{1}{10}$ of the beſiegers. Then to looke that the Counterſcarp (which is the ſhield of the Fortreſſe) be duly flanked, couert, and capable, that the falſe Ports and wayes for Sallyes, be ſafe, cloſe, lowe, and commodious for iſſue. That the the Parrapets be of Turffe, or vnburned Bricke, that the platformes for the Ordnance be euen, and the Planks cloſe ioyned, that their Reuerſes cauſe not errours, and be alſo capable for the Gunners and Labourers to trauerſe their Ordnance euery needfull way vpon them. The number of your Gariſon may alſo be eſtimated by the quantities of the places, to be defended by the out-workes you would hold, by the intrenchments imagined requiſite, and Sallyes you purpoſe to make. Now after the proportion of a Place whereas 60 Peeces will be requiſite, 12 of them may be Cannon, to beate downe, and batter the Defences and Trenches of the Enemies, and to make therewith Counter-Batteries, to diſmount the Enemies Ordnance; And 8 of them may be Demy Culuerings, & 10 Demy Cannons, they being lighter, are more eaſie to mannage, and 10 Sakers, to keepe the Enemie continually play to hinder their works, offend their Centinells, beat the entrances of the Trenches, impeach their Approaches, and for that they are light, they may be remoued eaſily and quickly from one place to another, yea out of the Ports with ſome Drakes, to rake the Enemies trenches, from ſome part of the Falſebray. And laſtly, 20 Falcons and Falconets for Field Peeces, are neceſſary, and may be able to ſerue, not onely vpon the Ramparts and Walls, but alſo at the entries of a Breach, and at ſingle Marks, Horſe, man, or Boat.

CHAP. XLVIII.

To make a Counter-battery vpon a Bulwarke, from whence without danger of diſcouering or diſmounting the Enemies Ordnance, abroad may be diſmounted.

SVch Counter-batteries are not to bee made without great labour and charges, neither can euery Bulwarke yeeld a ſufficient roome for that purpoſe, without demoliſhment of ſome buildings and houſes about the ſame (which in a time of neede, muſt not be ſtood vpon) as in the 10 Figure at β the whole ſtructure thereof is repreſented. All the place muſt then be of that capacity, that from the Parrapet to the foote of the ſholder, there

there may 40 foote of ground, and for the thickneſſe thereof it muſt be 21 or 22 foote, with 27 or 30 foote for reuerſe, for each Peece making almoſt 100 foote in all, and leauing yet thirty foote more at leaſt from the ſaid reuerſe to the other Parrapet of the ſame Bulwarke, to the end there may be no impeachment, but that the Troopes may march and paſſe to the defences required freely. And hauing alſo roome to plant three Peeces of Ordnance vpon each of the Shoulders of the ſame, which will alſo require 65 foote of ground at the leaſt: The *Trounniers* or Loopes are to be 3 foote broad within, and diſtant 20 foote one from another: Hauing within the Platformes 3 foote of Barb, and without 9 foote of breadth, and euery where 8 foote of height. Theſe three loopes muſt haue a counter loope at the Parapet of the Bulwarke, hauing in the midſt 4 within 6, and without 8 foote in breadth and deepe, that it be euen with the Terraplene. Now from theſe Loopes there muſt be, as we haue ſaid ſo much roome, that within the Shouldrings there may be 3 Peeces diſtant 20 foote aſunder. Now two or three of theſe Shouldrings diſcharge their three Peeces, trauerſing croſwiſe to the Enemies Batteries, beating ſo vpon them, that they muſt be forced to quit the place: And although the Enemie abroad may beate the Couertures of the outmoſt Loopes, yet can they neither for the inner Loopes, nor the Peeces within, come to touch any of them: But you may note that ſuch Batteries cannot be made in a narrow or ſtraight place, as I haue ſaid without demoliſhing ſtructures, and raiſing the ground ſo, that it be leuell with the Terraplene of the Bulwarke, which would otherwiſe be too ſmall for that purpoſe. And hauing finiſhed them, they are not to ſerue for one place onely, but they may turne thoſe Shouldrings and defences, and make the Peeces thunder about on all ſides where the Enemie would ſettle himſelfe.

CHAP. XLIX.

Of certaine reaſons that cauſeth a Shott, though well directed to erre in her diſcharge, and be faulty at the Mark wide, ſhort, or ouer.

THere are very many cauſes and accidents that may make a Shott well directed, to deuiate from the expected courſe. The firſt is, when as the Soule or bore of the Peece lyeth awry in the Body or Mettall thereof, or that the Chaſe or vacant Cillinder (the director of the Shott) is not ſtraite; wherefore the Gunner may receiue diſgrace, but hauing examined and found the fault, hee is to ſupply the defect by diſcretion and skill. And if the Trunions alſo be not duly placed directly in a dyagonall lyne with the Axis of the Peece, it will be wide: likewiſe if the Platforme bee vnequall, as higher vpon one ſide then the other. Alſo if the Gunner lay the higheſt of the mettall, at mouth and Breech, it will ſhoot ouer if it bewithin

diſtance: if one wheele be higher then another, alſo if one wheele goe ſtiffer then the other; or if one wheele meete with a ſquat by a ſtone, or otherwiſe when the Naues be one longer & wyder then the other, when one wheele reuerſing goeth on ſoft ground, the other on harder, when the Cariage or Trunion eares are higher & lower one then another: if the Cariage be too wyde, ſo that the Peece lyeth not faſt therein, but ſtarteth in her diſcharge: if the Shot be not equally round, or the bore of the Peece not lying ſtrait, but more on the one ſide of the mettall then the other. The vehemencie of the winde, with, againſt, or aſide, may driue the Shot forward, backe it, or deuie at it, aſide, the thickneſſe and thinneſſe of the ayre, the heating and cooling, the ſleight or hard ramming of the Powder, putting home or ſhort the ſhott. And laſtly, the want of skill and experience: All theſe, and many more, may be cauſes of the fayling of a Shott at an aſſigned Marke, which I thought fit here to note at laſt, not to miniſter matter of excuſe to ignorant, negligent, careleſſe Gunners, but to aduiſe the diſcreete Gunner to haue a vigilant eye, and conſideration of all, or as many of thoſe accidents with reaſon, & of the former directions, to auoyd or amend them as wel as he can at firſt. To faile at the firſt ſhott if he be not acquainted with the Peece and Marke is paſſable; and at the ſecond to fayle is pardonable, but to faile of a faire ſhott at the third time, is too much, and argues but little iudgement and diſcretion in ſuch a Gunner.

CHAP. L.

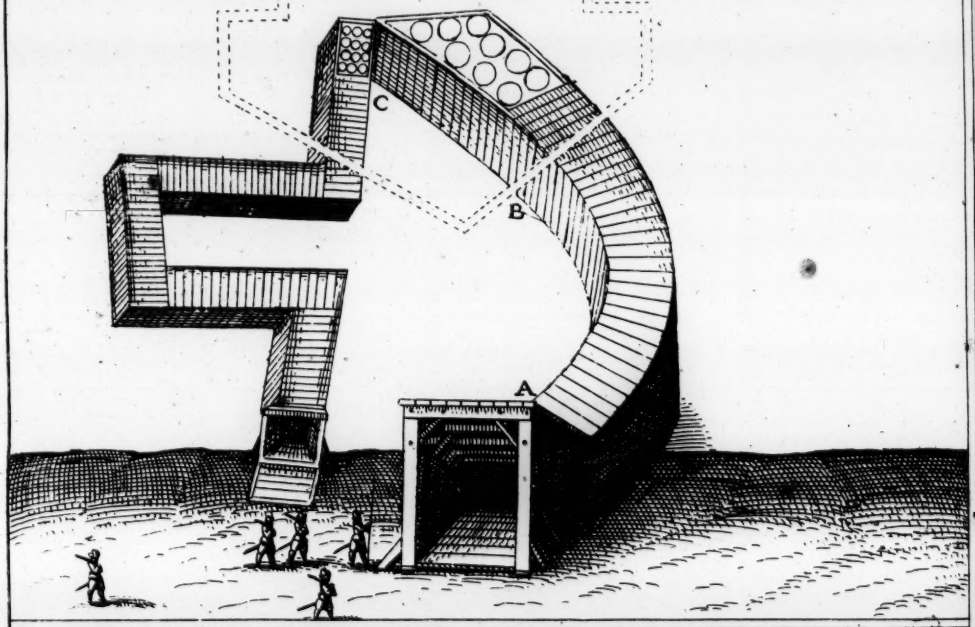
How to conduct a Mine vnder ground, to blow vp a place, and to prepare a Gallerie, to paſſe the Dyke to the foote of the Breach.

THe vſe of Mining is ancient, and was commonly vſed by the Perſian, Greeke, Parthian, Romanes and other Nations, that haue mannaged great warres, and no meruaile, for that the ſame is the eaſieſt, and moſt proper meanes to force a place: But *Pietro Nauarro* a Spaniard, was the firſt that inuented the Fowrne and the vſe of Powder therein, for which and ſome other ſeruices the Emperour *Charles* the fifth, gaue him the name of a *Conde*, and great rewards beſides. Yet neuertheleſſe, there is nothing more dangerous for ſuch as worke in theſe Mines, by reaſon the Counter-mines of the Enemie: ſo that if there be any ſuſpition of countermining, it will not be amiſſe to diuert the courſe with all dexterity, either toward the right or left hand, as the occaſion of the Place will permit. And foraſmuch as according to the naturall effects of feare, it behoueth the beſieged to ſeeke out the ſhorteſt and neereſt way poſſible, to offend the Enemie abroad by Countermine or otherwiſe. The Mine-Maſter then may ſinke his Mine, and conduct the ſame either as in the 16 Figure at α, is deſcribed by the letters from *A* by *B* to *C*, or as the other 4 ſquare angular courſe, and there to prepare the Fourne, which may be armed with powder in Barrels, ſo that giuing Fire thereunto by a Trayne, he blow

16
DEC

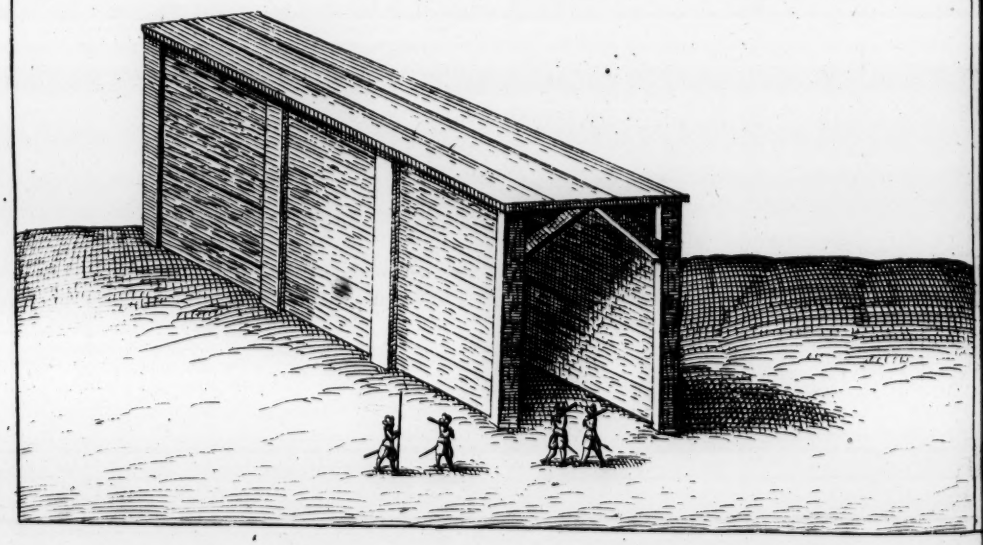
Comment il fault armer et conduire vne mine. *Tract. 2. Cap. 3.*
Wie eine minen zu leitten vndt zu verwahren.

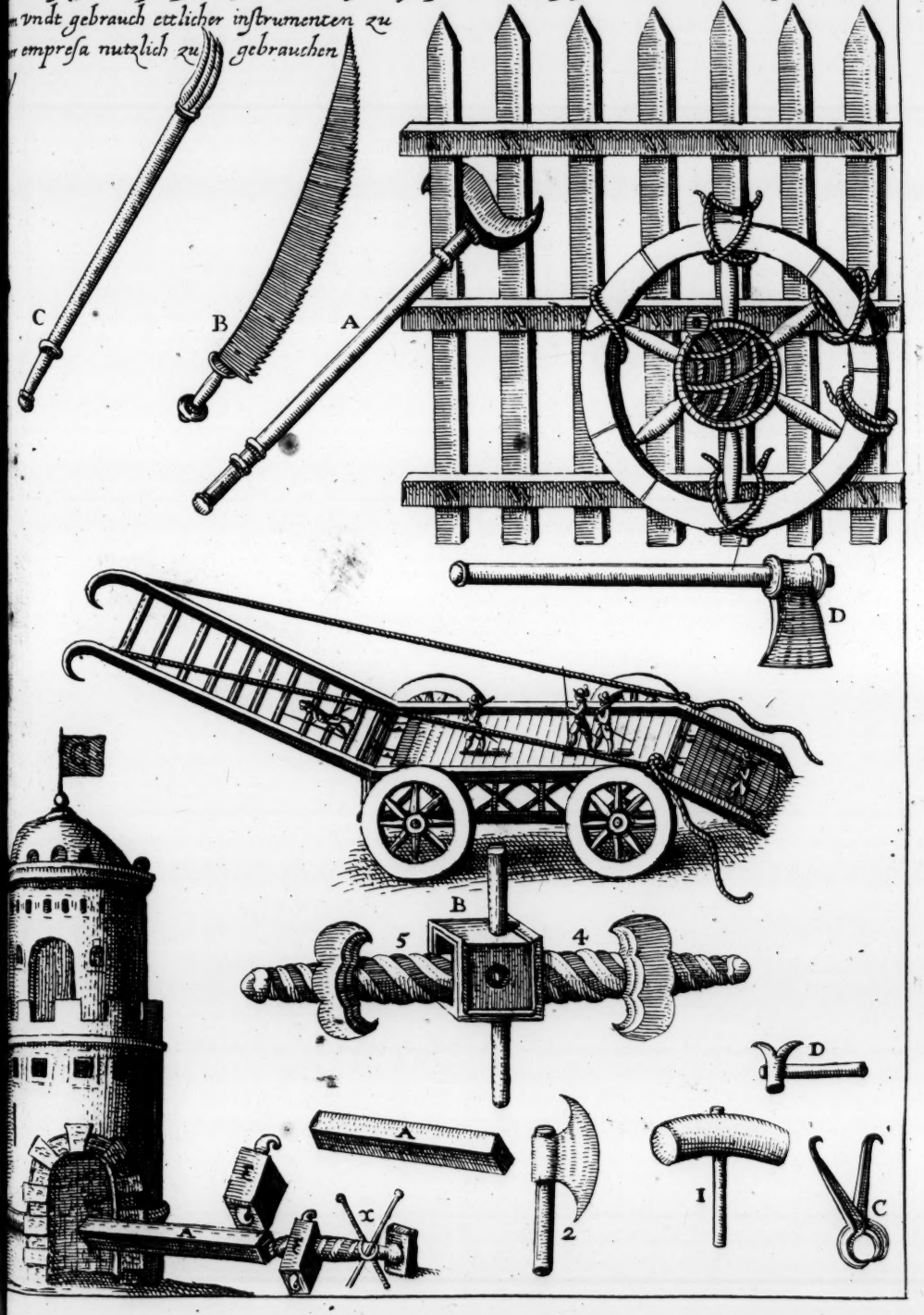
α



galerie.

β




C
B
A
D
B
5
4
D
A
X
2
I
C

BRITISH MUSEUM
DEC

blow vp the Place and the Enemies aboue it: And to the end the ſame hurt not the Pyoners or Worke-men that digge and trauell therein: it will bee needfull to lyne the ſame with ſparres and bords framed accordingly, ſeauen foote in height, and 5 foote in breadth, but it muſt be couered with 2 inch planke, to keepe vp the earth: But if the ground be moyſt or full of Springs, a gutter with a deſcent muſt bee made, that the water may runne to ſome lower euacuation; if that cannot be, a Well at the mouth of the Mine muſt be made for a receptackle for all the Springs to runne into by their gunters, and Pumpsor Forcers, are to be ſet ſufficient to mount the water, that it may after finde a current to runne away. But if there be any ſuſpition of Countermining; then alwayes forwards in your intended courſe, you may bore long holes in the earth with your long ground Awgars vſed for ſuch purpoſes, and pierce holes on all ſides, alſo to know vpon what part from you the Enemie worketh, which cannot be done ſo priuate, but ſo the noyſe of their Mattocks and Shouels will ſoone be hard by thoſe pierced holes, when you come neere their workes: if by thoſe meanes you heare nothing by reaſon that the beſieged had ended their Countermines before you began, and he watching them heareth you worke, thoſe piercers being but 12 or 15 foote long, will diſcouer the danger by boring thorough the ſolid earth, to the hollowneſſe of their Countermine; and ſo you ſhall haue Counteraduantage of the Enemies counter-minings. My Coſmodelite before repreſented, is an excellent inſtrument, and for that purpoſe I thinke the beſt extant.

Now being come right vnder the place to bee blowne vp, and made the Fourne arched vpwards higher then the Mine place, therein ſufficient powder, either in Barreil or Troughes, you muſt alſo ſtop cloſely and ſtrongly the mouth of the Fourne, very diligently, looking it be ſo cloſe that no ayre breath out, but at one ſmall hole wherein the Trayne runneth in to giue fire thereunto; vnto which he that giueth fire, muſt looke that the Match of the Trayne, bee not too long before the powder take, as alſo to ſee it bee not too ſhort, and ſo to giue fire too ſoone, that is, before he be gotten into ſome place of ſafety out of the blaſt and ruines, leaſt hee pay the wages of improuidence. The meanes then to ſet the matter a worke, needes no long diſcourſe, being very commonly knowne, onely to aduiſe that the enterance into the Mine for height and breadth as aforeſaid, may be as cloſe and ſecret from the Enemie as may be, and that in his proceeding on, he muſt deminiſh thoſe meaſures in ſuch manner, that in the midſt it be but 5 foote high, and 4 foote broad: And the neerer you come to the end, ſo much the leſſe giue in breadth, ſo that euen to the comming in to the Furne it muſt be cloſe and narrow, that you may onely get the powder thereinto.

Aboue all things, the Mine-Maſter before he begin, muſt be ſure to know the true meaſure and diſtance, with the height or depth of the place intended to bee Mined, bee it aboue or vnder the leuell of the place hee beginneth, moſt preciſely taking exact notice of all his windings, turning, and angles, which he maketh from the beginning to the end, as well aboue and vnder the leuell of the right line, paſſing thence right vnder the Place, as towards the right and left ſide thereof: Otherwiſe his labour will not onely be deficill, but alſo vncertaine and moſt dangerous: there being foure principall

causes to impeach the effectuall working thereof. First, the ill stopping of the Fourne: Secondly, the weakenesse of the sides by countermines or Caernes. Thirdly, by failing of the Trayne by moysture or ill contriuing. And fourthly, the most important, is, that the Frame whereupon the Barrels stand, be not placed too low, as vnder the leuell of the enterance, which it must euer exceede, because the quality of fire is alwayes to ascend. And so obseruing euery 15 or 20 paces, how high, or lowe, or wide on any side you are gone, aboue or vnder the leuel strait line. Two of the greatest shames to Souldiers, being either to lose any peece of Ordnance, by negligence or ill guarding them: Or the fayling of a Mines due effect.

And for making great or small *Galleryes* to passe a dyke vnto a Breach couertly, be the dyke watered or dry, the maner is described in the precedent Figure with the Myne, and may be made ready in seuerall parts, to be set together speedily by ioynts, fitted for that purpose, for the easier cariage also. And they must be couered ouer with Faggots, earth, & greene Hides to preuent firing them.

Chap. LI.

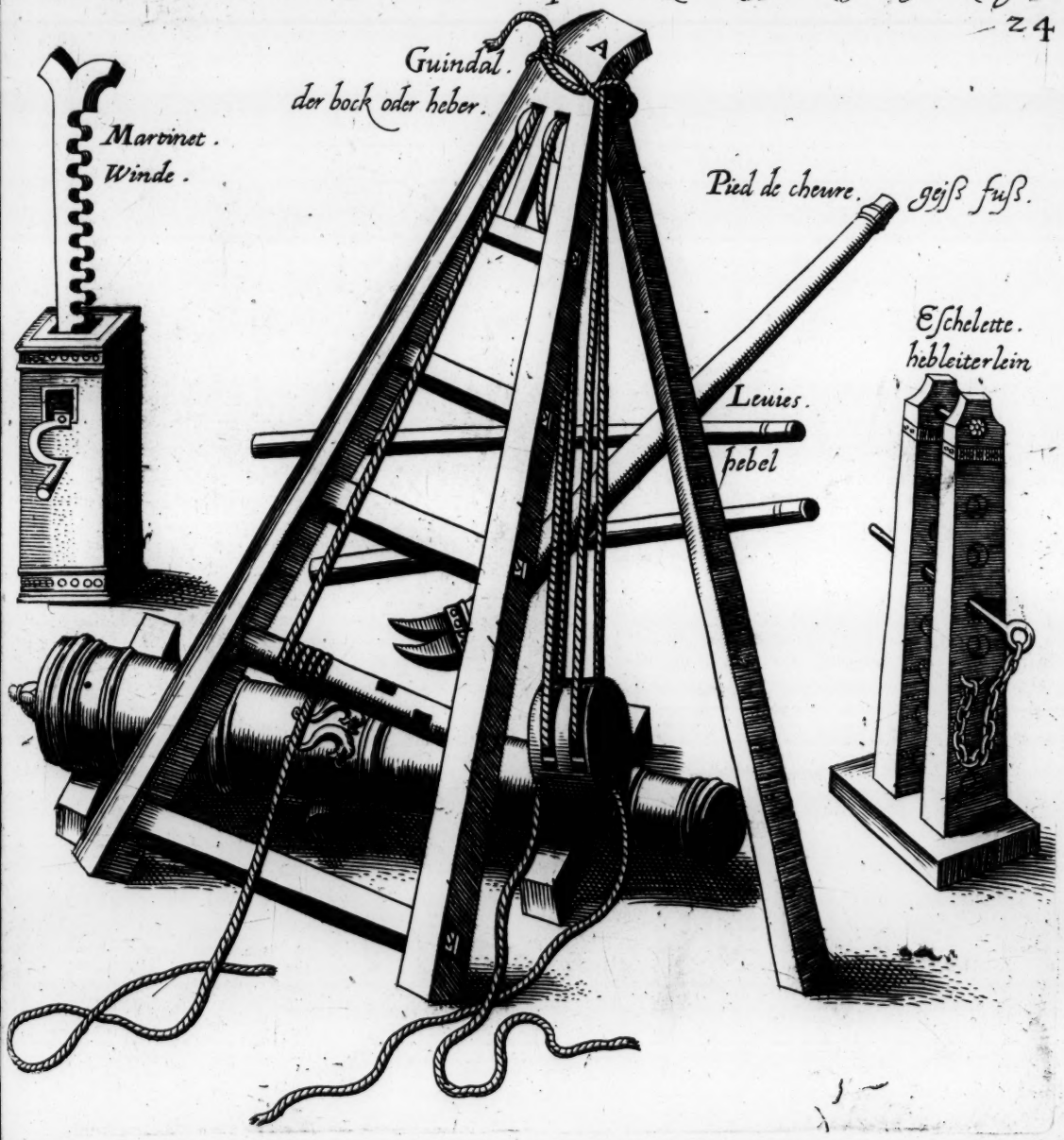
Of the Guindall, Windlas, and Ginne, or Martinet, Krow, and Handspyke, and Leuer, and the endlesse Screw.

THe *Guindall* or *windlas*, is a conuenient ingenious inuention, to mount a peece of *Ordnance*, or heaue aloft waighty matters, and is represented in the 24 Figure, with the Crow of Iron, or Goates-footed Handspyke, and Leauers, accompanied with the *Ginne* or *Martinet*, which will lift vp the Axtrees, when the Peece is vpon her Cariage mounted, to take off, or put on the Wheeles, to grease, or ease, or mend what is amisse about them. The Guindall is thus made of a peece of Tymber, sixe inches square in the feete, or with three young dry Oken Sparres, about 12 or 15 foote long, ioyned together at the top with an yron bolt, passing through Iron Ferrills, vpon which bolt a double pulley is hanged, and at the lower end of each Sparre another yron Ferrill, and a Pyke of yron is placed to keepe the feete from all slipping, almost at the lower end of two of those legges or Sparres, a peece of a Sparre about 4 or 5 foote long, is fastned betweene them, and also 3 foote from the end, a Rowle and Windlas, with halfe round yrons, are claspd to those 2 legges or sparres, and aboue that 2 or 3 other peeces of sparres: In that Rowle, are 4 mortis holes, for Handspykes, pierced thorough, whereby they with 2 or 4 Handspykes turne that Rowle which hath an end of a rope 4 or 5 times, or more about it, and the other end reeued in the said Pulley, so continued vnto another double pulley, with a hole or hooke to take hold, or seize a Rope that hath slung the Peece, appointed to be mounted into her Cariage: Or else the Frame may

be

Les Instruments pour le seruice des pieces. Tract. 3. cap 8. Der zu dem geschutz gehörig hebzeug.

Z 4



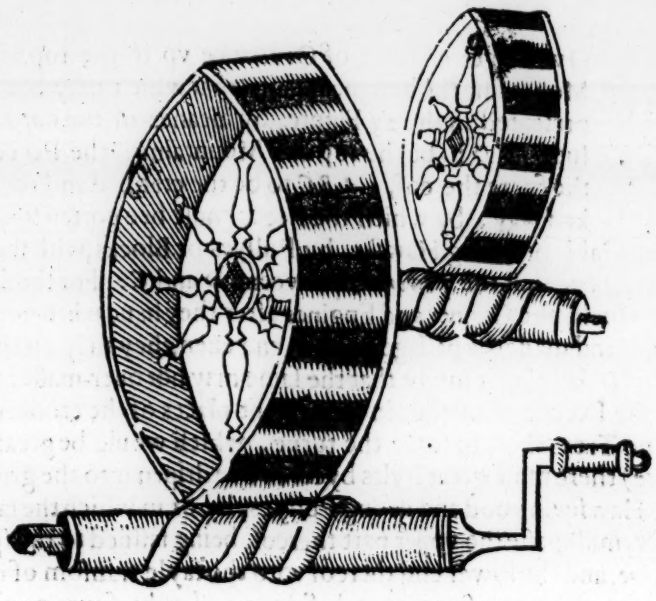
BRITISH MUSEUM
DEC

Comment on peult mener vne piece d'artillerie sur vne montaigne. 23

Wie ein stuck auff einem berg zu zihen.

BRITISH MUSEUM
DEC

be of 3 ſquare Tymbers, the head of two of them ioyning at the top together, and the reſt for the other legge and parts, may by the ſight of the ſaid 24 Figure, be framed and vnderſtood ſufficiently.



The Ginne or Martinet is another inſtrument, ſeruing to lift vp the Peece with her Cariage, and all her furniture from the ground with one mans ſtrength, when the Gunner would change a bad wheele, or the like, or put a wheele on vpon the Axiltree, or take it off for any purpoſe, the proportion of this Engin for the vſe of Ordnance, is that it ought to be about 2 foote long, and 8 inches ſquare, or there-abouts: the Viceron is of yron forked, to take hold, and with his teeth is wound vp by a handle, with a ſpurre of fewe teeth, it will lift a great waight, multiplying the force proportionally, according to the height of the ſecret wheele, and of the ſaid ſpurre (contained in the diſtance of the handle, from the centre of the ſpurre) or to ſemidiametre of the handles circular reuolution, dyametrally multiplied by the reaſons betweene the ſpurre and wheele. That Viceron commeth out of the midſt of the ſaid ſquare caſe of wood, at the top thereof, and by his Fork or Eſſe, taketh hold of whatſoeuer is fitted to bee lifted vp. The Scaletta with the reſt may be eaſily made, vnderſtoode, and vſed, as in the ſaid 24 Figure is deſcribed. And for the ſame or any the like purpoſe, the *endleſſe* Screw of *Archimedes* here aboue repreſented, is of infinite effect being duly applyed.

CHAP. LII.

How to draw a Peece of Ordnance vp to the top of a steepe and rough hill or mountaine.

HOw to get a Peece of Ordnance vp to the top of a steepe Mountaine the best manner is, that which may bee seene represented in the 23 Figure, by meanes of the *Capstane:* As suppose *D* to be the top of a Mountaine, the Peece being at the foote thereof, *A BC* to be the crabbed and rough crooked way, by which the Peece must bee gotten vp, drawne with a long Cable or strong Hawser, by Pullyes or Blocks, with sheeuers to make a Battery against the *Tower F*, betweene *D* and *C:* For the better effecting of which, the Gunner and Enginer after they haue taken good notice of the Place, and made the passage smooth and euen, they may place the *Capstane* behind *D*, fastning it surely, that the same may not ouer-master the great poyze of the Peece: And then in conuenient places of the crooked way (if there be no Trees there to serue the turne, which would be great helpes if there were) there must great Pyles by force bee driuen into the ground, to fasten the Hawser in good and strong Pullyes, by or in which the said Cable or Hawser, must passe the vpper part thereof, being fastned to the spindle of the *Capstane*, and the lower end thereof vnto the tayle transom of the Cariage or Rings neere the same, at each side one. Lastly, foure or more men turning the *Capstane* about, with the Barres thereof, shall first make the Peece to mount vp vnto the first Pulley or Block at *A*, where it must be first scotched, vntill the Blocke be taken away, by taking out the Pinne or Axis of the sh euer, and then the Peece is to be tauersed towards the second Block or Pully *B*, and so to the third *C*, and then to the desired place neere *D*. It were also needfull to haue a small Truck, as well to beare the Tayle vp, from staying against rough stubs or stones in the way, as also to helpe the motion, Labourers also must be readily attending neere vnto the Peece, as well to aduance and helpe the Motion, by heauing and shouing the same, as to trauerse the Peece the righteſt and best way, as occasion shal require, as in the said 23 Figure may bee seene. And after each Pully, hath performed his office, let a man be ready there with greace, vineger or Lye, to annoynt the end of the Axtree, that it may soke into the Naue, least the waight of the Peece in that Motion fire, and also to haue an eye to each of the Pullyes, that the Cable breake not. And if any danger of its breaking be perceiued, then to giue warning to them aboue to stay, and to them alow to scotch, vntill the Cable be changed or amended- But if the hill be so rough and steepe, that the meanes aforesaid will not doe it. Then take the Peece out of her Cariage, and either lay it vpon a blocke Cariage, or on a Sled with Trucks, and lay plankes along in her way where it is rough, and vse then the *Capstane* and Pullyes as aforesaid. You may also vse for the same purpose *Archimedes* endlesse Scrue, represented in the 51 Chapter.

CHAP.

CHAP. LIII.

How the Traine of Artillery and Ordnance ſhould be ordered with their Cariages in a iourney, or vpon a March.

THe whole Trayne of Artillery, one body deuided into two parts *Van* and *Rier*, is wholy vnder the command of the Maſter, or Generall of the Ordnance, or in his abſence vnder his Lieutenant or Braue, imagine then that the Army be with ſuſpition according to aduiſe, to be ſet vpon by the way, both in the *Van* and the *Reire*. Then were it fit 500 Horſe deuided into two Troopes, ſhould aduance, to diſcouer all the Coaſt of the Champion, with the dangerous wayes, Woods, Thickets, and ſuch like, by which the Army muſt paſſe, after theſe 2000 Foote, ſhould march as well for Couerture as guard of the Ordnance. And they alſo to be deuided into two ſquadrons, furniſhed with all neceſſaries of defence. After them the Trayne of Artillery, with the Ordnance, marching with their Conducters, Waggons, and Cariages of Powder, Shot, and Tanpions, or Wadding, Coynes, and Beds, together with a reaſonable number of Pyoners, and ſome Marriners, and ſuch like ſpare people, to bee ready to make Couerts and defences for the Ordnance and Gunners, or to cut wood, to plaine the wayes for the *Van* to paſſe with foure field Peeces, ready mounted in their Cariages, with all their neceſſaris, as Ladles, Spunges, Rammers, Crowes, Leauers, Ropes, Tables, and breechings, with experienced Gunners, Gentlemen of the Ordnance, Mattroſſes, and Conductors. After follow the Munition and *Engins*, ſeruing for the vſe and defence of the *Rier* of Artillery, with the Boats and Bridges, and then againe follow 8000 Foote, and after them the great Ordnance, either in the Cariages with fore-Cariages, or elſe vpon block Cariages, whoſe wheeles being higher, makes the draught the eaſier. And laſtly, follow 3 or 4 Field Peeces ready mounted, accompanied with all their neceſſaries and apurtenances of Powder, Shott, Inſtruments, and Attendants. After which there march 2000 foote more, that are for Couerture and defence of the Ordnance and Riere of the Trayne: theſe are followed with 500 Horſe to cloſe vp the Army, whoſe Charge, is, to ſee that the *Rier* of the Trayne bee not ſet vpon at vnawares, ſuddainly, or vnprouided. The Army then Marching in this Order, The Enemie ſhall finde the *Van* and *Riere*, and alſo the Body furniſhed with force in all places. And being alwayes ſo prouided with the Trayne of Artillery diuided into 2 parts, yet remaining one Body: ſo furniſhed, as that no doubt but a good and a happy iſſue wil ſucceede ſuch good equipage, well guarded with Horſe and Foote, prouided for defence of the Artillery, to march without danger, but in large capable Champions. This Trayne may bee ſhortned, the *Van* taking the right hand, and the *Rier* the left, and the Trayne betweene both, equall in Front with *Van* and *Rier*, and ſo Marching more compact, it will be the ſtronger: as in the 6 Figure at *a*, by the letters *ABC* is repreſented to the eye.

CHAP.

CHAP. LIIII.

How to draw Ordnance if Cattell be wanting, by the strength of Pyoners or Labourers.

ARtillery or Ordnance, being the principall instrument of the Warres, requireth a great strength of Cattell, either of Horse or Oxen, to transport them from place to place, which being wanting, must in a iourney bee supplied by Pyoners and Labourers: as imagine that 16 Peeces were to bee imployed against a Place to bee forced, consideration must be had (Cattell being wanting) how those Peeces, whereof 6 are Demy-Canons, 4 are Demy-Culuerings, and 6 are Field Peeces, that shoote 6 *l.* ball, and how all the prouision that belongeth vnto them, as Powder, Shott, Waddings, and Cordage, &c. may be transported thither, the Place to be forced being scituate in a rough, stonie, and hilly ground, by Pyoners and Labourers onely, sparing the Souldiers for other seruices. The Amunition and Persons that must carie them readily, are first to bee considered of: As 600 Shott for the Demy-Cannon at 30 *l.* each Shott, will be 18000 *l.* loaded in Wheelebarrowes 2 Shot, in a Barrowe which will be 60 *l.* for a Man, and will require 300 Men to driue them. Also 600 Demy-Culuering Shot of 10 *l.* loading 8 Shott in a Barrow, will require 75 Men, each man carrying 80 *l.* And 900 Shot for the 6 Field Peeces of 6 *l.* each Shot, putting 13 Shot in a Barrow, will bee caried by 69 Men, each man carying 78 *l.* except 3 of those men, which shall carie 14 Shot a peece, that is, 84 *l.* each of them: So all the Shot will be caried by 444 Men. The strongest men which carie most, are loaded with the waight of lesse then a bushell and a halfe of Wheat for each man in a Wheelebarrow, which hee may easily driue. Then for the Demy-Cannon, loading them with 18 *l.* of powder for each Shot, will for the 600 Shott amount to 10800 *l.* euery man carying 80 *l.* in a bagge, will require 135 men.

And for the 600 Demy-Culuering, allowing each Shott 8 *l.* of powder, will come to 4800 *l.* each man carying 80 *l.* 60 men will transport the same.

And for the 900 Shot, for the 6 Field Peeces, allowing 5 *l.* for each Shott in powder, that will amount vnto 4500 *l.* which at 60 *l.* for each man to carie, will require 56 men, & a Boy to carie the odde 20 *l.* of powder ouerplus, which will amount almost vnto 180 barrells of powder, each barrell containing 112 *l.* nete.

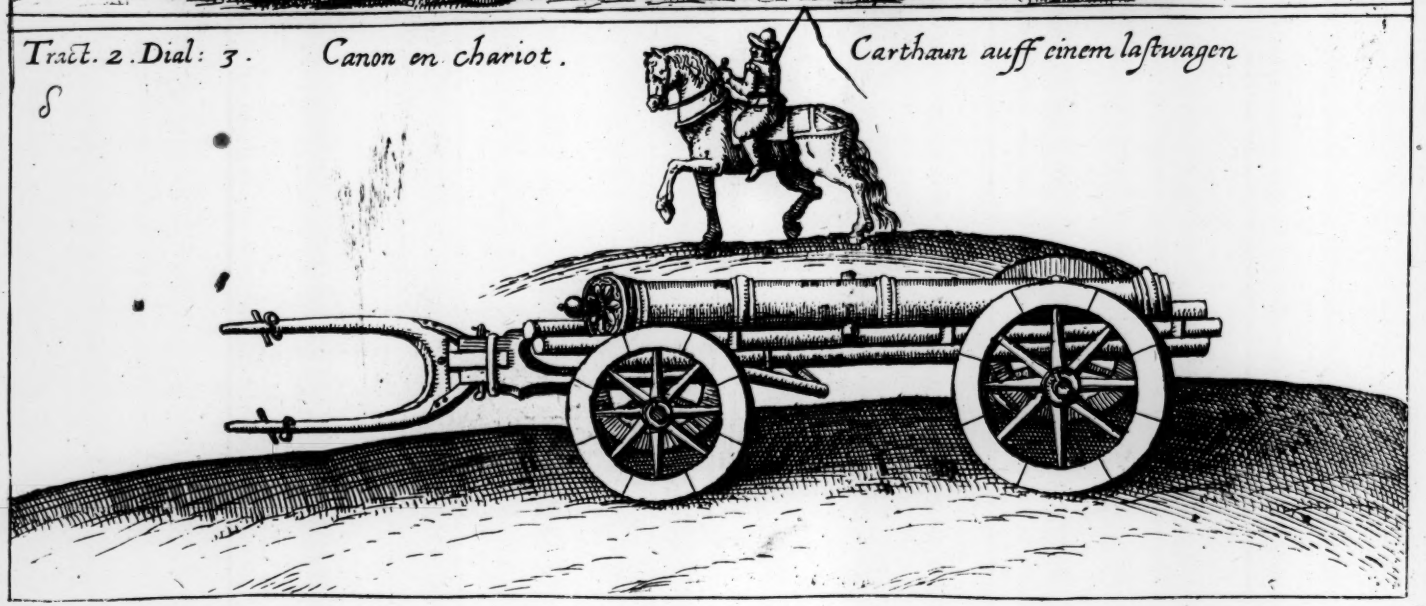
And for the Furniture of the Peeces, the Figure 5 [a], sheweth the manner of drawing them by 3 lines or traces equally deuided, according to the number of men that are to draw them, so that the Demy-Cannon with her Cariage, waighing 6000 *l.* reckoning 60 *l.* for euery man to draw, it will then require 100 men, and so the fixe, fixe hundred men.

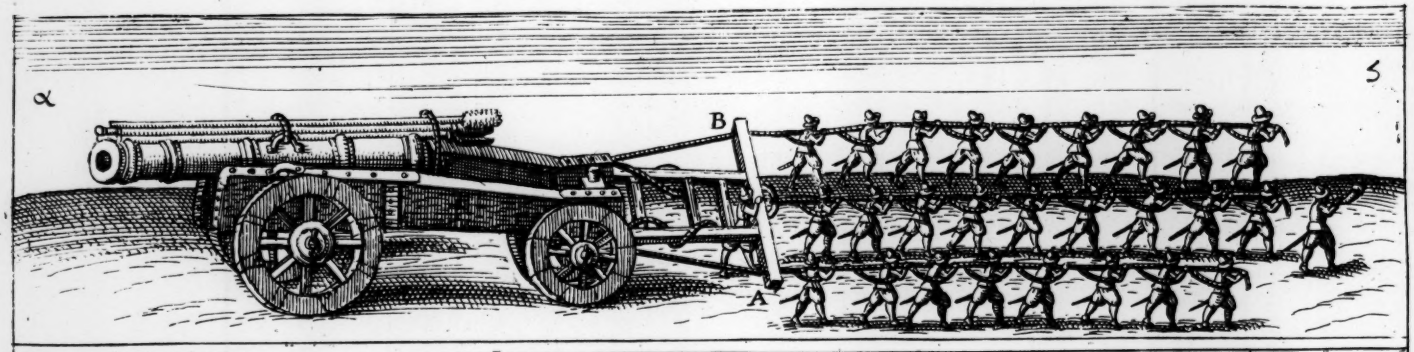
The

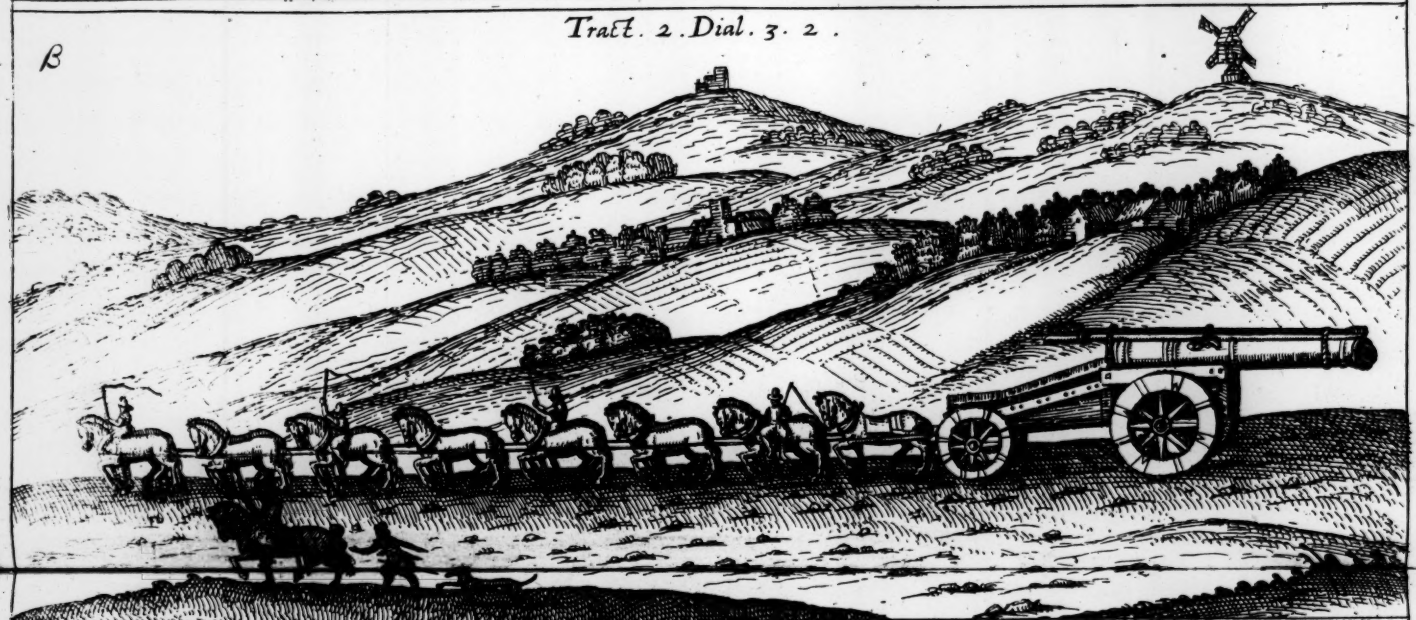
Comment il fault pour faute de cheuaulx conduire tant les munitions que l'artillerie. Tract. 2. Dial. 22.

Wie in mangel der pfer de beides munition vndt geschutz vort zu bringen.

Tract. 2. Dial: 3. Canon en chariot. Carthaun auff einem lastwagen




α
5
B
A


β

The 4 Demy-Culuering Cariage, and all waighing about 2400 *l.* will require 40 men, to draw each of them, ſo 160 men will at 60 *l.* for each man ſerue to draw them.

The 6 Field Peeces with their Cariages, waighing about 2400 *l.* a Peece, will each of them require 30 men, ſo the 6 will be drawne by 180 men, each man drawing 60 *l.*

Now foraſmuch as there may be cauſe often to diſmount and remount a Peece by the way in the iourney, it will therefore bee fit to haue ready the *Gyndall* or Winlas, and the Martinet or Gynne, & when they are to be drawn vp any ſteepe hill, then alſo the *Capſtone* Cable & Pullyes in the 2 laſt Chap. deſcribed, muſt alſo be caried, all which may be caried by 40 men with eaſe: ſo that for the Cariage and tranſportation of all theſe Amunitions in any iourney (where Cattell are not to bee had) may bee caried and drawne by 1675 men and a Boy without any difficulty.

It may alſo be demanded, becauſe in ſuch an expedition, that many other things will be needfull to bee tranſported for the Ordnances vſe: As Ironworkes, Nayles, Crowes, Hooes, Fore-Cariages, Greaſe, and ſuch like: But ſeeing they may more eaſily bee deuided amongſt the Labourers, there reſteth for them no difficulty of tranſportation. And for the better drawing of the Ordnance for each Fore-cariage, a long Tranſome or Whiping-tree muſt be faſtned afore it, as betweene *A* and *B* is deſcribed, that the 3 Ropes or Traces may bee placed equidiſtantly, farre enough aſunder to auoyde trouble, and becauſe the Traces will be ſome of them too long, an other Trauers or Whiping-tree, or two may in the midſt, or in conuenient places be faſtned to thoſe, or elſe other Traces rather may goe betweene Whiping-tree and Whiping-tree, to keepe the ſo long Traces from ſwaying, with too much trouble to ſtagger the men in drawing, and ſo hinder their draughts. And three men behinde would be needfull to guide the Cariage in the bendings and turnings of the way. Vpon the Traces alſo each man muſt haue a double Cord faſtned to the Traces, which hee muſt put ouer his ſhoulder Scarff-wiſe, and laying his next hand on the Tract, hee may ſo draw with all aduantage.

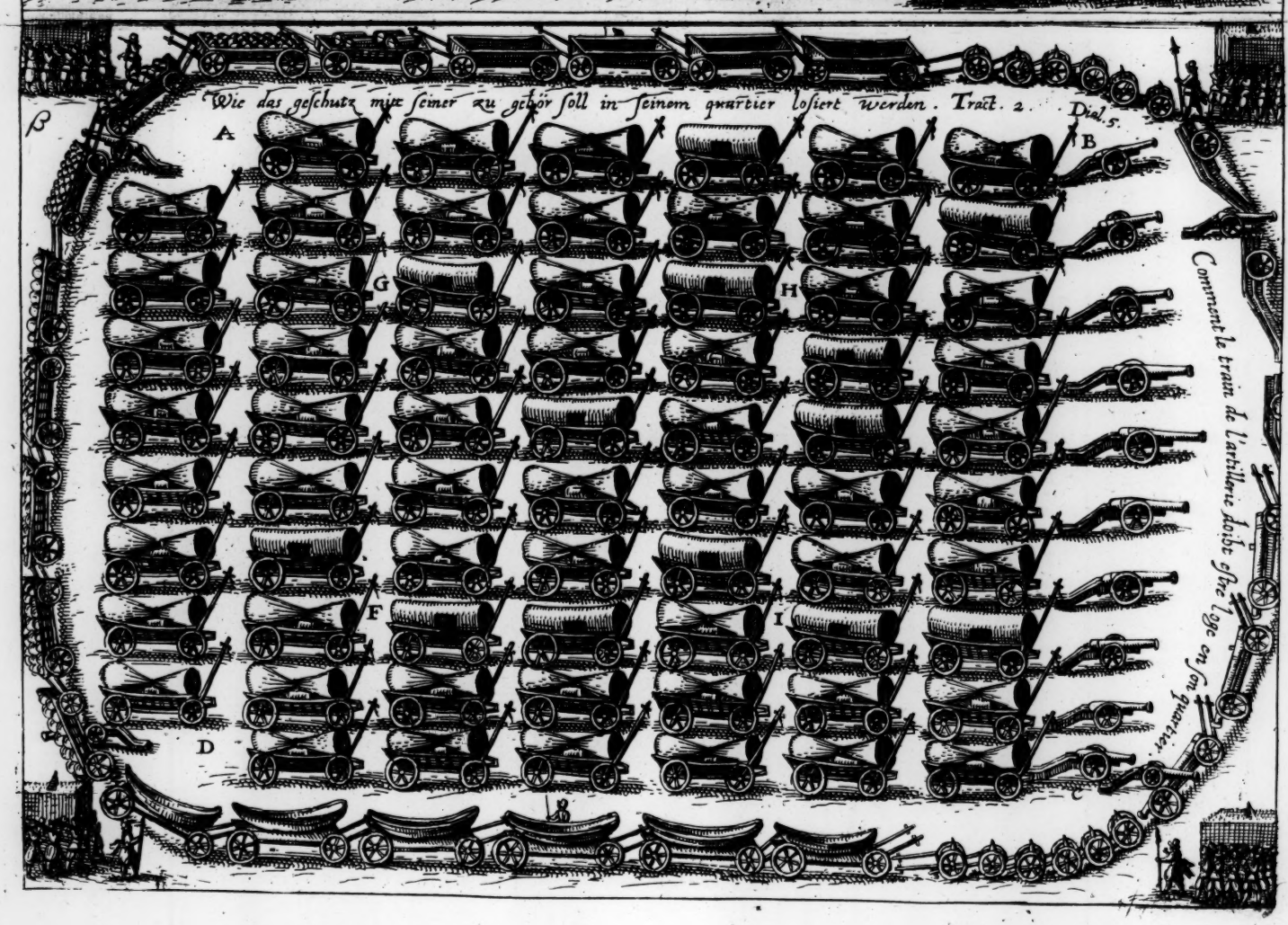
And for Horſe or Oxen, allowing each Horſe to draw 500 *l.* and each draught Oxe 600 *l.* The ſame may eaſily be thereby found how many Cattell will be requiſite to tranſport the aforeſaid, or any other aſſigned quantity of Munition for any iourney. The manner of the Mannaging, whereof is repreſented in the ſaid 5 Figure at *β*. And the carying of the Shott and powder in Wheelebarrowes and Bagges, is deciphered in the ſaid 5 Figure at *V*. And laſtly, the deſcription of a Peece ready furniſhed for a iourney, with Cariage and Fore-cariage, Ladles, Spunge, Ramers, &c. is in the ſame Figure repreſented at *ſ*.

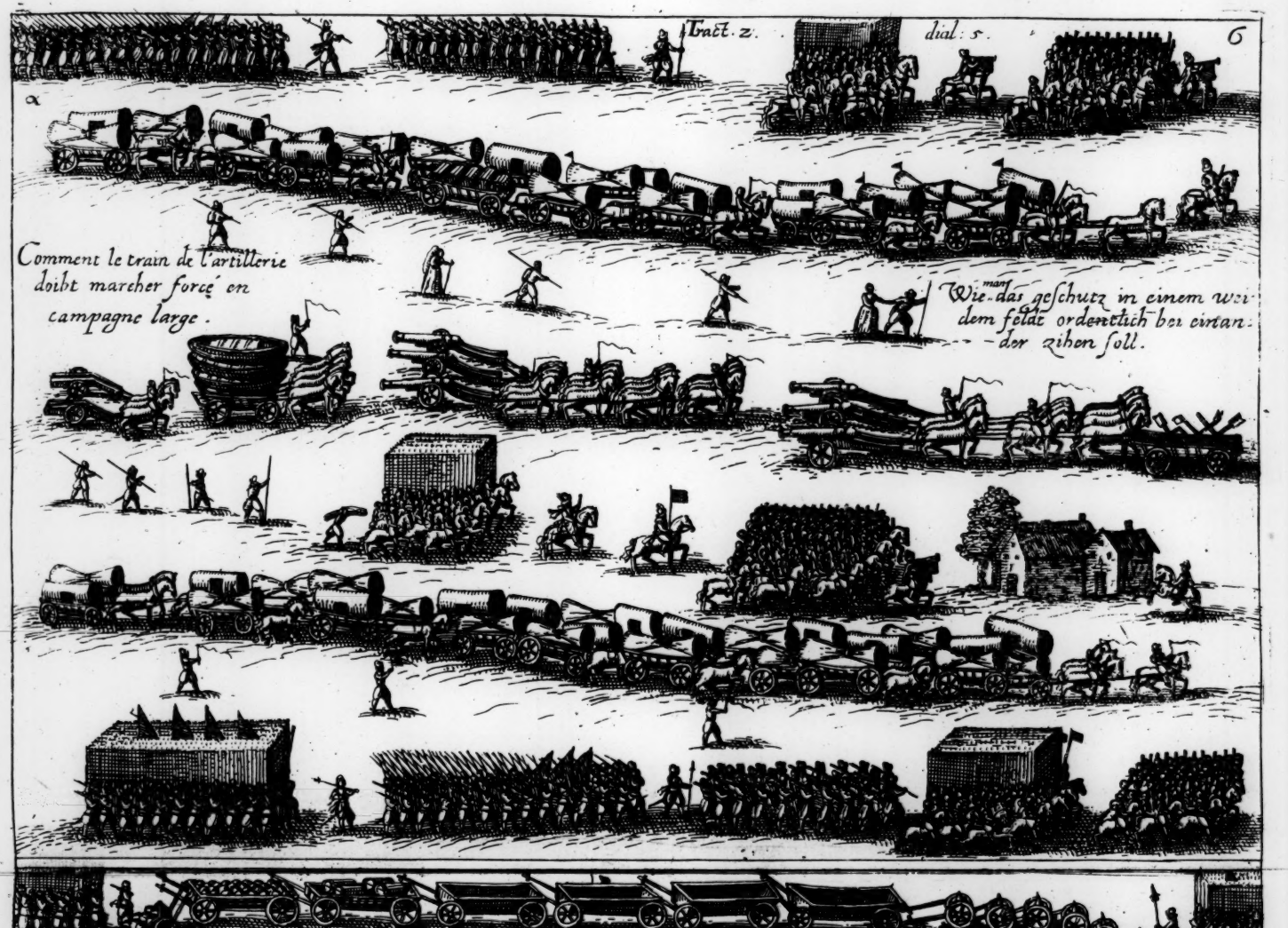
CHAP. LV.

How many Priuiledges the Trayne of Artillerie haue more then ordinary in Marching and Lodging.

IF it happen that in Marching, any other Cariage offer to aduance before any of thoſe of the *Traynes* Cariages (except the Treaſurers Cariage) then the Maſter of the Ordnance hath power to command & compell the contrary by Priuiledge, whereof they enioy more then others, becauſe of the extraordinary waight of the Ordnance and Shott, and for that they haue charge of the principall inſtrument of the Warres, and therefore hath the firſt Ranke, without contradiction, and ought to haue the beſt Quarter and Lodging, and to be firſt ſetled therein. And in March in a Champion they of the Trayne of Artillery, are to march more cloſe and ſhort, then doth the Vant or Reire betweene which two and the *Batallion*, they are alwayes ranged or placed, as may appeare in the 6 Figure at α. And the Generall or Maſter of the Ordnance, is to haue care that his Trayne bee timely lodged, to haue time to prouide all commodities needfull. And if it were poſſible that they may be ſo lodged, as to diſcouer the whole Champion about them, whereof theſe aduantages would ariſe: Firſt, that they may diſcouer all approaches: ſecondly, that the Campe may bee the better defended thereby. And thirdly, the Enemie aduancing to giue an aſſault to the Campe, they may by them the better be repulſed. But for their Lodging, the order repreſented in the ſaid 6 figure at β, it muſt be obſerued. Firſt, that betweene the Retrenchments made with certaine Chaines of the Munition, and with the empty Cariages and Fore-cariages, they may bee encloſed, ſo that there may be roome and ſpace, that the Footemen appointed for their guard and defence, may if neede be skirmiſh, which for that purpoſe, hold the places therein marked *A B C D*, hauing 25 paces breadth at the leaſt. And ſecondly, that the Peeces of Aduice, whereof there are alwayes 3 or 4, regarding all the wayes of the Enemies Auenewes, which are euer ready charged and fitted in all things. And laſtly, that the Cariages of powder be lodged in the middle, as about the centre or midſt of the other *Cariages*, as you may ſee by the letters *F G H I*.

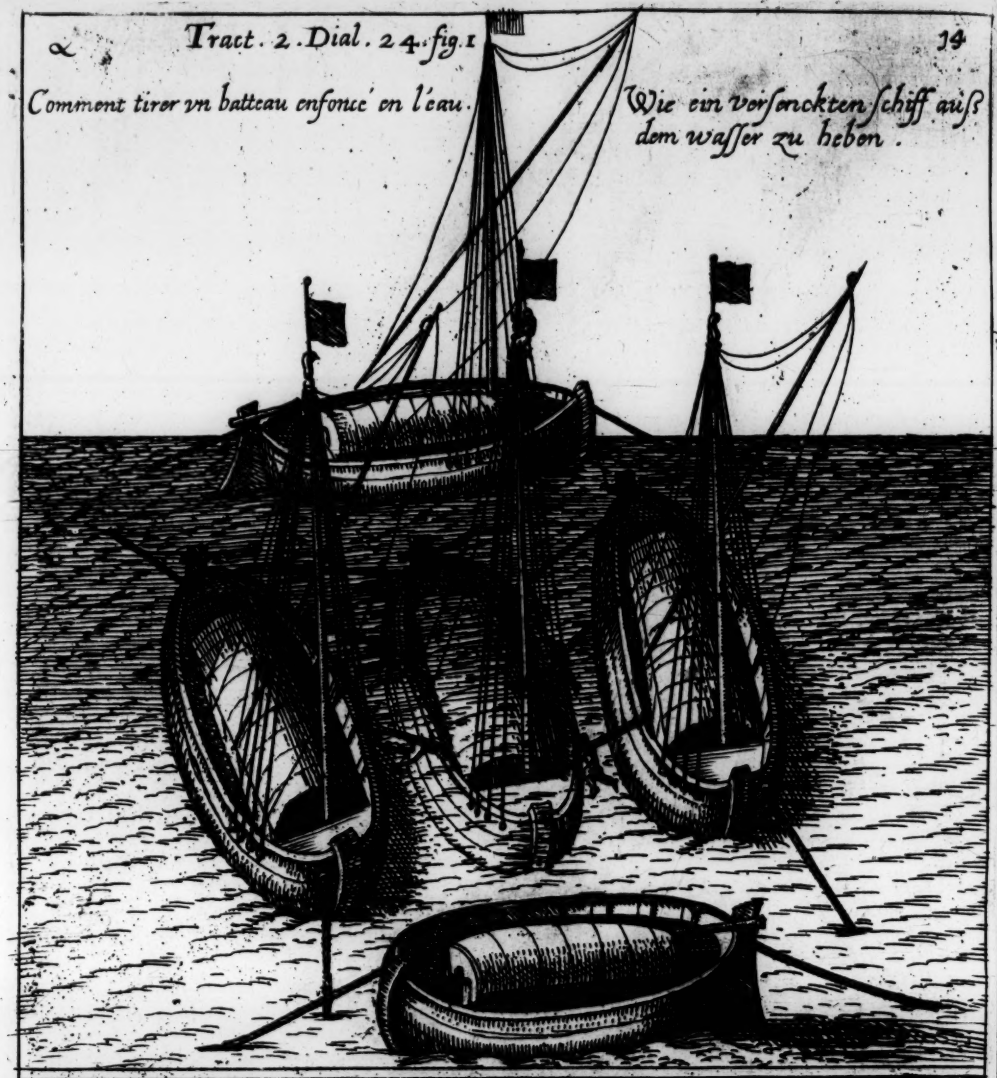
16
30
DEC


Wie das geschutz mit seiner zu gehör soll in seinem quartier losiert werden. Tract. 2. Dial. 5.
Comment le train de l'artillerie doibt estre logé en son quartier.
A
B
G
H
F
I
D


Tract. 2.
dial. 5.
6
a
Comment le train de l'artillerie doibt marcher forcé en campagne large.
Wie man das geschutz in einem wit dem felde ordentlich bei einander ziehen soll.

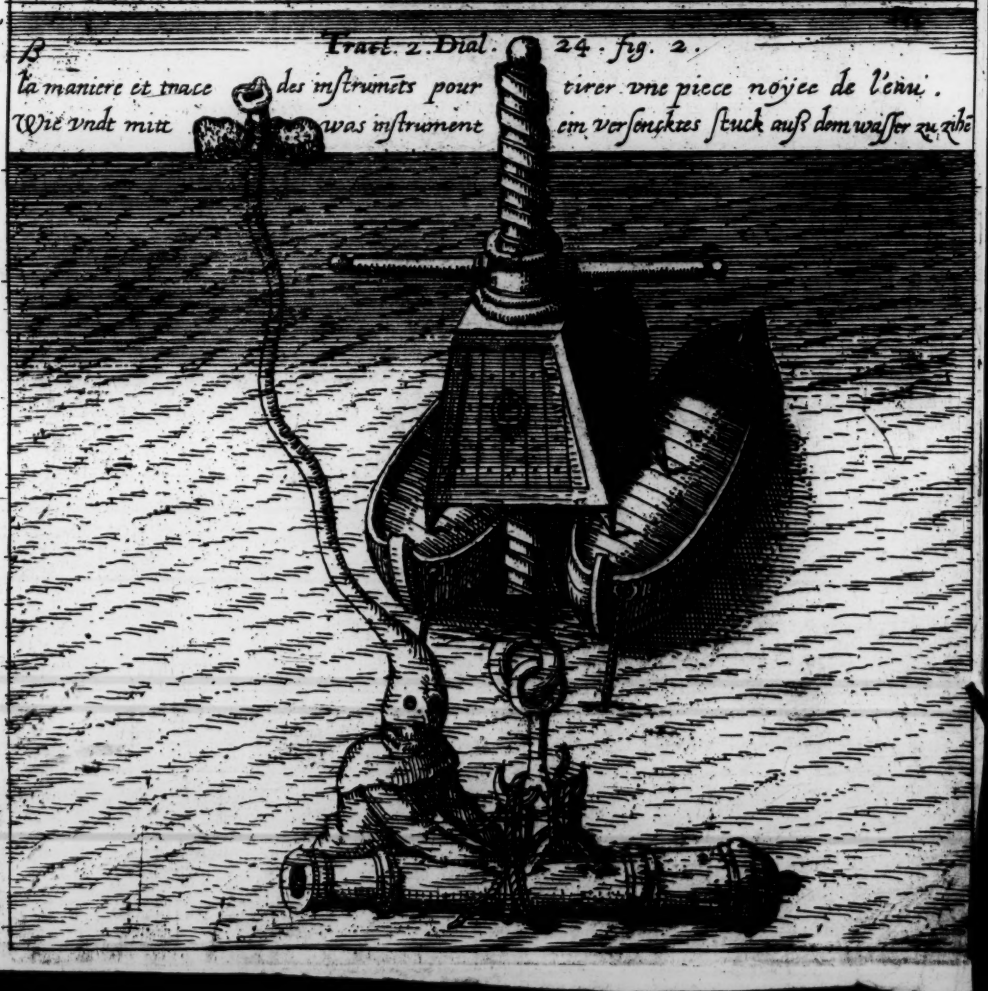
Comment tirer vn batteau enfonce en l'eau.

Wie ein verſonckten ſchiff auß dem waſſer zu heben.



La maniere et trace des inſtrumẽts pour tirer vne piece noyee de l'eau.

Wie vndt mitt was inſtrument ein verſonckтes ſtuck auß dem waſſer zu zihẽ



Chap. LVI.

Shewing how to waigh a Peece of Ordnance, or a Ship ſunke vnder water, and the proportions of all Mettalls and Ordinary ſtone, what, or how much they will waigh in the Ayre, and how much in the water.

IT being a certaine thing, that whatſoeuer is heauier then ſo much water, as the body of the matter thruſteth out of the place will ſinke, and being lighter then ſo much water will ſwim, as *Nicholas Tartaglia* hath not only well collected frō the learned *Archimedes*, but alſo calculated not onely the proportions of all the ordinarie ſorts of Stones and Mettalls, whether in Ayre or Water, according as they poyze in both; And alſo notably expreſſed their ſurrounded accidents, in his Treatiſe intituled by him *Noua Scientia*, wherein he deliuereth as followeth. Namely, that ordinary *Free ſtone*, waighing 93 *l.* in the Ayre, will waigh but 48 *l.* in the water, which is neere as 2 is to 1 betweene the Free ſtone and water.

And that Marble ſtone that waigheth 7 *l.* in the Ayre, will waigh but 5 *l.* in the water, which is neere 7 to two, betweene the Marble and the water.

And Iron and Tinne that in the Ayre waigheth 19 *l*, will waigh 16 *l.* in the Water: ſo Iron or Tinne is to water, as 19 is to 3.

And Braſſe waighing in the Ayre 65 *l*, will in Water waigh but 55 *l*, and ſo Braſſe is to water, as 65 to 10.

And Lead and Siluer waighing in Ayre 30 *l*, will waigh in Water but 27 *l*, ſo Lead and Siluer are to water, as 10 to 1.

And laſtly, Gold in Ayre being 17 *l.* waight, will in the Water waigh 16 *l.* ſo Gold is to Water as 17 to 1.

And in the firſt declaration of his ſaid Booke, he ſheweth how by a Concaue Globe of Glaſſe, hauing a hole to put in a mans head vnder it, being ſet in a Frame of Tymber in the forme of the Frame of an Houreglaſſe, with a Winlas, Rope, and waight thereat to ſink. A man entered into that Frame, to the bottome of the Sea, or other deepe water, his head being within the ſaid Concaue, Glaſſe, Globe (wherein he may both ſee and breath, being no water can enter into the ſame.) And when he will againe riſe to the top or ſurface of the water, vnwinding the Rope (being long enough) the frame and his body in it, will-in like manner mount vp as hee pleaſeth: and the waight remaining at the bottome of the water, and the Rope going through the bottome of the Frame, it will guide it to goe vp vpright.

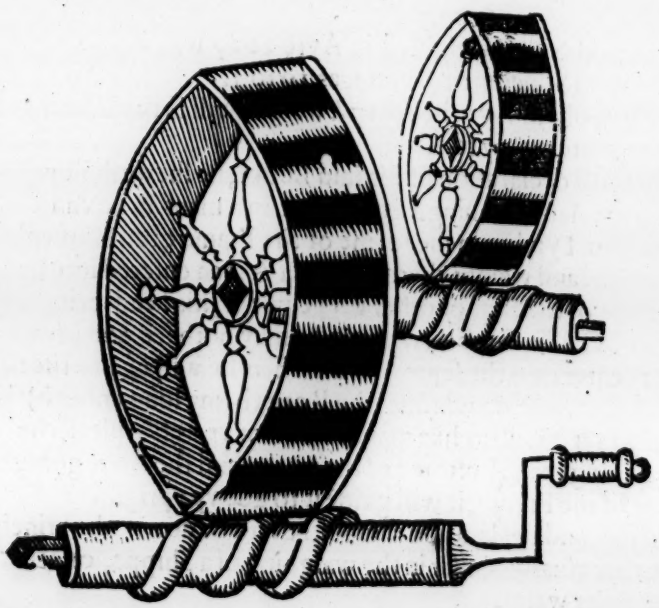
And in his ſecond declaration thereof, he ſetteth downe the principall impediments, that vſually hinder in the waighing of a Shippe, or other heauie thing ſunke vnder water.

Firſt, if it be docked, or haue made his bed, or impreſſion at the bottome.

Secondly, if it be filled or couered with Sand or Oaze, ſo that ſufficient Ropes cannot be faſtned thereunto to ſling the ſame.

Thirdly, how to get the thing ſunke, to ſeperate it ſelfe from the bottome of the water, where Ayre cannot come betweene, which will be harder to cauſe ſuch ſeperation, in muddy, oazy, or ſandy ground, then in grauelly or ſtony rocky bottomes; yea, and with more difficulty to, in very deepe then in ſhallower waters.

And laſtly, that it is harder to waigh things that haue beene long, then ſuch as are but newly ſunke, becauſe it and the bottome will bee ſo ioyned and cloſed together, that to ſeperate them, Nature refuſing to let vacuity to come betweene them, they at the firſt will bee found loath to depart. But hauing faſtned Ropes to ſling the ſunken thing, either by his helpe ſunke in the ſaid Frame, or elſe by the meanes here in this 14 figure at *g* repreſented, which may be conceiued, a man entered into a caſe of leather made ſo thight, that no water can ſoake in, and with a payre of glaſſe Spectacles faſt ſet, and cemented cloſe, with a pype of leather boyed by bladders blowne, at the brim or top of the water, whilſt he faſtens the Ropes below. Then 2. 3, or 4 veſſells being ankered ouer the place, and firmely faſtned together with Timber beames, the ſlinging Ropes alſo faſtned to a mayne Tymber betweene the veſſels, being deepe loaded at the firſt, faſtned of the ſaid ſlinging Ropes, and after the veſſells being vnloaded and lightned, will bee more boyant, and waigh to their power: Or elſe if the ſlinging Ropes bee faſtned to their ſtems (they being loaded forward) and afterwards the loading remoued aft, towards the ſterne of the veſſels, they will then waigh all their Force: And where the water heightens much, if Ropes be faſtned at low-water, at high water, they will haue boyed the ſunke thing, or done their moſt force and helpe they could.



Laſtly,

Laſtly, alſo if 4 Veſſells bee faſtned, ſo that a ſquare ſpace be betweene, and one or two of *Archimedes* endleſſe Scrues called *Tripaſtons*, here in a liuely figure, repreſented with which, hee ſaid hee would moue the world out of his place, if he had a firme foundation to plant his *Engin* vpon *Datum pondus datis viribus mouere:* There will be therefore no doubt, but induſtry and diligence ioyned, will produce the wiſhed effect: and ſo knowing the lading or waight of the Ordnance in the Ayre, as each thing would waigh in a payre of Ballance, the matter being Mettaline, then *Tartag* his true proportions will helpe, or if other goods, then induſtry will ſoone finde how much all will waigh in water, which let ſuffice at this time.

CHAP. LVII.

How Moulds, and Formars, and Cartredges are to be made vpon them, to Load and Charge any Peece of Ordnance, without any Ladle.

HAuing already ſhewed how to loade any Peece with, and without a Ladle: Now I will ſhew how to make *Cartredges* ready for all Peeces, wherewith in time of ſeruice any Peece will bee more ſpeedily and certainly loaded. *Cartredges* are either to bee made with Canuas Fuſtian, or other linnen cloath, or with thicke ſtrong Paper, eſpecially of Paper Royall: which prepared, take the height of the bore of the Peece, without the vent of the Shott, and cut the cloath or paper of the breadth of three ſuch heights, and in length, for the *Cannon* 3, for the *Culuering* 4, and for the Saker Falcon, &c. 4½ of the heights of their proper Bores, and leauing in the midſt at the top and bottome one other ſuch height, at each place to make a couer and bottome for the *Cartredge*, cutting each ſide and end, ſomewhat larger, then the ſtrict meaſures appointed for the ſowing or glewing of the ſeames thereof, ſo much as will counteruaile the ſame, hauing alſo a reſpect for augmenting and deminiſhing thoſe meaſures, as the powder ſhall bee better or worſe then ordinary, and alſo abating with diſcretion, when as your Peeces ſhall be already heated in fight, leaſt elſe you endanger the breaking or ſplitting of your Peece. Hauing reſolued then for what ſort of Ordnance your Cartredges are to ſerue, you are accordingly to haue a Modell or Former of wood turned of the height of the Shot, and of a conuenient length, longer then the Cartredge is to be. Then if you make them of Canuas, halfe a dyametre is to be allowed more in breadth for the ſeames: but if they be made of Royall paper, then hauing lapped it once about the Former, leaue about ½ inch ſurpluſſage more then will compaſſe it, which with Starch, Paſte, or mouth Glew, cloſe about the ſaid Former, hauing ſome part of the ſame ſubſtance, fitted vpon the end of the Former; firſt for a bottome, which muſt alſo be paſted or glewed cloſe, and faſt to the ſide of the *Cartredge*, ſo that being dry, it may hold the Powder faſt, and ſure from ſpilling. And you

muſt remember firſt to tallow the ſaid Former, ſo that the *Cartredge* being ſo moulded thereon, it may be eaſily and without tearing, ſlipped off againe. A patterne for theſe Cartredges is here in this 20 figure repreſented. Now hauing ſhewed how the *Cartredges* are to be proportioned and made, it reſteth alſo to ſhew how a peece of Ordnance is to be loaded with them, wherein we are onely to conſider, that if the Peece be Chamber-bored, it muſt be layde in a Scaffeta, or Semicircle, or Cillinder of wood, of the thickneſſe of the *Orlow*, or different thickneſſe, or height of the Mettall betweene the Chamber and Chaſe, or elſe the Cartredge will be hardly gotten into the Chamber. Alſo if the Peece were Taper-bored as the *Drakes*, and ſome ancient *Cannons* are, then the Mould, muſt accordingly be made to taper for the making of Cartredges for her, and her Ladle muſt alſo be cut tapering-like, the figure repreſented at *T* in the laſt figure but one; but if the Peece be equall bored, and the *Cartredge* made of Paper, then there is no more to doe, but to put the *Cartredge* into the mouth of the Peece, and with the Rammer-head, to put it home, to the bottome of the bore of the Peece, with two or three eaſie ſtroakes: and then with a ſharpe three ſquared Pryming Iron, to cut and pryme the Cartredge, that the Powder prymed at the *touch-hole*, may giue fire to the quick powder thereby. In all other things for wadding before and after the Shot, and ramming home the Shot, you are to performe the vſuall manner taught in his proper place.

CHAP. LVIII.

The names of the principall members, and parts of a peece of Ordnance, as they are to be called and knowne by.

THe names, kindes, and ſorts of each Peece of Ordnance, with their differences, waight, meaſures, and in their fortifications, being already handled in the precedent *Chapters* hereof, needes not here be repeated. But in regard the moſt of them haue ſpeciall parts common, and of like names, I will ſpeake a word or two thereof, and ſo proceede to the manner of making and proportions, belonging to the *Cariage* of each particular Peece, as in the next Chapter will appeare. The whole peece together, or as much thereof as is matter of Mettall, may by the 2 definition of my Booke of the Art of Artillery, be called the body of the Peece. The hollow Concaue, Cillinder, or Bore of the Peece, may be called the Soule, by the firſt of the ſame. The whole length of her ſhaft or Colume, is the *Chaſe*. So much of her bore as containeth the Powder and Shott, is the *Chamber*, or Charged Cillinder, and the reſt of the ſame is called her Guide or vacant *Cillinder*. The two ſpindles or eminencies that come out about the midſt of her chaſe, whereupon ſhe (in her Cariage) is mounted or imbaſed, are called her *Trunions*. The moſt afterward pummell at her breech, is called the *Caſacabell*.

The

The little hole neere the breech, whereby ſhe is prymed and fired, before her diſcharge, is her *Touch-hole*. All the Mettall behinde the Touch hole is the *Breech*. The greateſt and moſt eminent Ring or Circle of Mettall at the Breech, is the *Baſe ring*. The next Circle or Ring before betweene the Trunions and the Touch-hole, is the *Reinforc'd ring*: the Circle or Ring next before the Trunions, is the *Trunion ring*. And the Circle which is formoſt, and moſt ranke and eminent at her Mouth, is her *Muzzle ring*. Laſtly, the Ring betweene the Trunion Ring and the Muzzle, is called the *Corniſh ring*, and the part of the *Chaſe* of her ſhaft contayned betweene the *Corniſh* and Muzzle, is called her Neck. And all the Rings, Circles, and eminencies at her Mouth, are called the *Freize*, taking theſe names frō *Pillers* or Columes, which ſomewhat repreſent the Chaſe of Ordnance: being in forme of the *Scapus*, of a Piller or Columne ſo neerely, that they take the names of ſome ſuch part of Pillers, as they neerely repreſent.

CHAP. LIX.

Of the making Proportions and Meaſures of euery part of a Field Cariage for any vſuall Peece of Ordnance aſsigned.

AT being moſt certainly a matter of great importance for ſeruice, to haue the *Cariages* of all the Ordnance, with their *Wheeles*, *Axtrees*, and their Furnitures to be ſtrong, well proportioned, and neat, and gracefully wrought, ſo as the Peece mounted therein be euery way ſo duly fitted, as that in the diſcharge of her Shot, nor in her Reuerſe ſhe may not remoue from the Angle wherein ſhee was directed. Wee haue thought good here to ſhew the due meaſures and proportions for all Field Cariages, both by figures repreſented in the 19 figure at β, and alſo by rules and diſcourſe as followeth. But firſt, a word or two of the reaſons and different opinions of ſome of the beſt moderne Authors, that haue written of this ſubiect. *Louis Collado* affirmeth, that long *Cariages* are better then ſhort: firſt for their more agillity in reuerſing: ſecondly, for the much leſſe ſhaking of the *Cariage*, *Axtrees*, *wheeles* and *Plat-forme*, ſaying, that Ordnance mounted vpon ſhort *Cariages* in a few times diſcharging them, make them vtterly ruinous and vnſeruiceable by their paſſions in reuerſe. But *Alexander Bianco* commendeth the ſhort rather then the long *Cariages*: firſt, becauſe they then require leſſe roome to reuerſe in, and that being loaded, they are ſooner brought againe to their place of ſeruice: And laſtly, that a Peece ſhooteth further, being mounted vpon a ſhort, then it would doe vpon a long *Cariage*. Both being moderated ſpeake reaſon, as Peeces are yet accommodated: but becauſe I know that any Peece of Ordnance may without any inconuenience be ſo fitted, that it with a ſhort Cariage, it ſhall leſſe ſhake the *Cariage* and Plat-forme, ſhoote further, and reuerſe leſſe by farre then in theſe as now they are fitted will do.

There-

Therefore although I with *Bianco* approue of ſhort *Cariages*, were they fitted for them, and with *Collado* as they are yet fitted: yet I will here ſhew the meaſures and proportions of late vſed, of the beſt Cariage-makers, and are made according to the directions of the moſt experienced *Gunners*, which although it be moſt particularly appropriated to the *Cannon*, yet with the deſtinctions following it may well leade to the proportionall, making and meaſure of a good *Cariage*, for any vſuall peece of Artillary whatſoeuer as followeth. The ſides and *Cheekes* called *Limbers*, ought to be of *Elme* or other Planke that is not apt to ſplit and cleaue, which for the *Cannon* muſt be once and $\frac{1}{4}$, and for the Culuering and ſmaller Peeces once and $\frac{1}{2}$ the the length of the Peece, and for each of them, they muſt be one dyametre of the proper bore of the Peece in thickneſſe and in breadth, at the head of the *Cariage*, it muſt be 4 dyametres, at the firſt bending 3, and at the tayle, 2 dyametres of the bore or height of the Peece.

The *Tranſomes* are to be in breadth 1 Calibre, and $\frac{1}{2}$ of the bore, and in thicknes one Calibre, except the *tayle tranſomes*, & coyne, which muſt be 2 Calibres broad, and 5 long, whereof $\frac{1}{2}$ Calibre may be let with a mortis into the cheeks at each end, and it muſt haue a bar of iron paſſe through the midſt thereof from ſide to ſide, with a hole for the Pintle of the *Fore cariage* to enter into; on either ſide of this tranſome there muſt paſſe an yron bolt from one ſide to the other, with an yron or roſe on each out ſide, to hold them firme together.

The next *Tranſom* forwards is the *Coyne Tranſom*, which muſt be 4 Calibres in length, that is 3 Calibres betweene the *Cheekes*, and $\frac{1}{2}$ of a Calibre, let in at each end into the cheeke, vpon this the breech of the Peece is to reſt his bed and coynes.

The next forwards is called the *bed Tranſom*, becauſe the fore-part of the *bed* reſteth thereupon, and the backer part of it reſteth vpon the *coyne tranſom* This is alſo 4 Calibres in length, but $\frac{1}{4}$ Calibre at each end is likewiſe let into the cheeke neere to the Axtree, ſo 3 whole Calibres thereof will be left diſcouered betweene the cheekes.

The formoſt is called the *head Tranſom* or *fore-Tranſom*, which is 3 Calibres, and $\frac{1}{2}$ in length, with $\frac{1}{2}$ at each end alſo let into the cheeke, and ſo leaueth 2 Calibres, and $\frac{1}{2}$ diſcouered betweene the ſides.

Through each of theſe *Tranſoms* there muſt paſſe an yron bolt (at the leaſt, for the greater ſort of Peeces) from ſide to ſide: By meanes of theſe 4 Tranſomes all the *Cariage* is locked faſt, as into one entire body, and is plated and bound ſtrongly with yron, that the ioynts open not with the vehemencie of the reuerſe. And thus is the *Cariage* in his perfection, ſo that if it were armed with his *Axtree* and *Wheeles*, the Peece might be thereon mounted, and ready to doe ſeruice.

CHAP.

DEC

Tract. 3. Cap. 2. fig. 2.

α

Kreutzstenglein. Croisette.

Eschelle pour examiner le bain de la piece s'il et droit ou non

Eine leitteren darauff erforschet ob der lauff an einem stuck gleich oder vngleich ist.

Ceci y est explique desoubs chap. 5.

Disser ist drunder im 5. cap. erkläret

C F A E D

H N L M G

Comment il fault mesurer vne piece.

Wie ein stuck soll visieret werden.

O

H N M L G

bouche. metal. mundloch.

C F A E D

bouche. metal. mundloch.

la cueilliers de charge.

Die B ladschauffel.

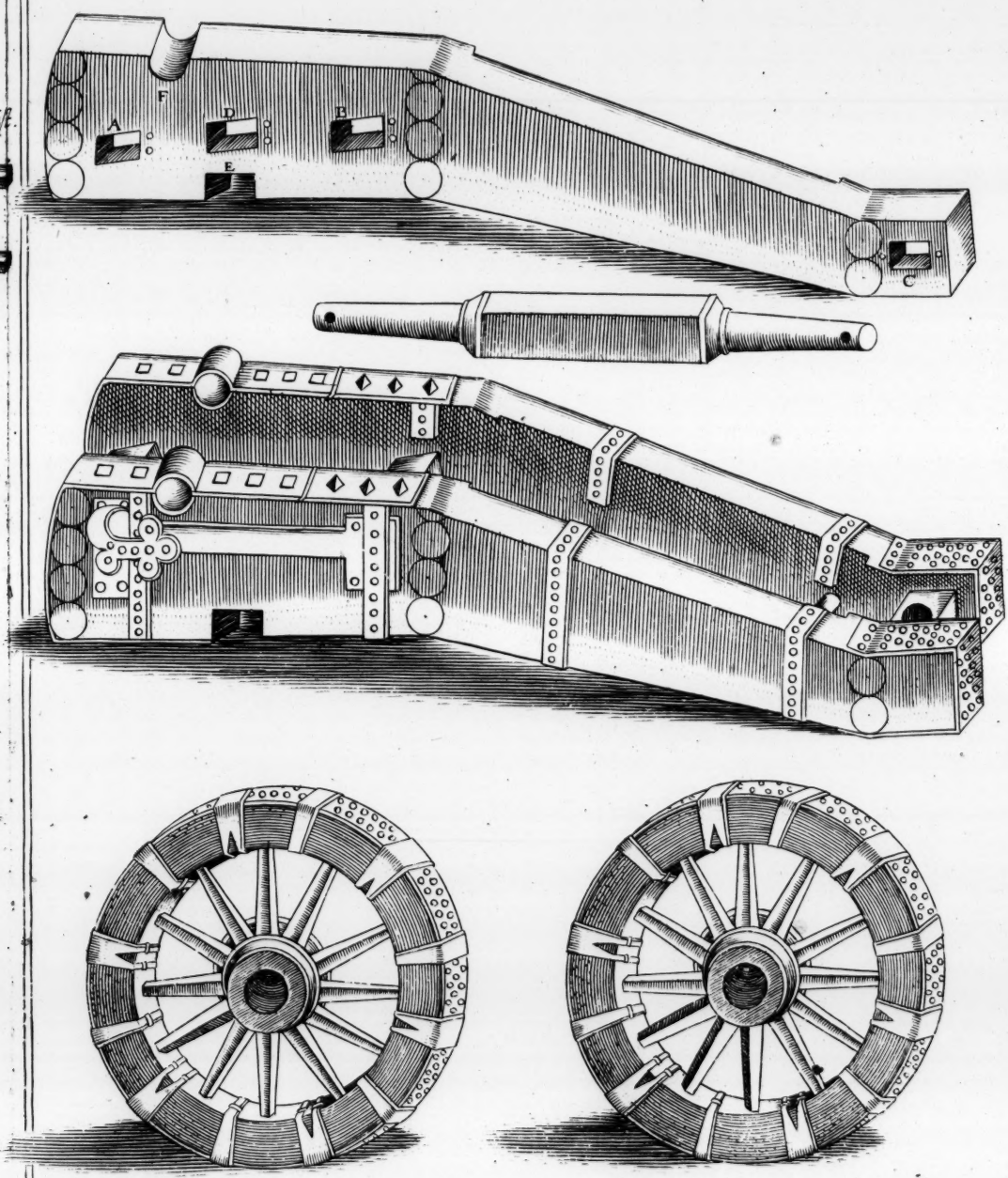
Regla pour signer les lignes droitte.

Zoll stab daran die strack linien zu zihen.

19

B

gleich ist.



CHAP. LX.

Of the Wheeles and Axtree for Cariages for Ordnance.

THe *Wheeles* ſhould bee in height about $\frac{1}{2}$ the length of the Peece, but in that conſideration muſt be had of the height of the Parapet where they are to ſerue. And for the Saker, Falcon, and ſmaller Gunnes, the height of their Wheeles muſt needes exceede that proportion, namely by $\frac{1}{12}$ for the Saker and Minion, and by $\frac{1}{6}$ for the Falcon and Falconet, and by 1 quarter for the baſe. The Fellowes or Circles of Timber-worke, muſt bee in length 4 dyametres $\frac{11}{16}$ of the bore, whereof there muſt bee 6 to make the whole circumference, and each of them one dyametre in breadth, and one in thickneſſe: For the greater Peeces, they are to be ſhod with yron ſtrakes, graſped and nayled with 2 or 3 Rankes of great head Nayles, as in the figure 19 at β is repreſented.

The Naue or head is to be in thickneſſe 3 dyametres, and in length 3 and one halfe, armed with Circles or Hoopes of Iron, and faſtned with ſtayes of Iron, that they ſtirre not from their places, nor goe round vpon the Timber of the Naue. The ſpoakes or Rayes are to be in length 3 dyametres, namely ſo that being let into the Naue one halfe, and into the Fellowes one halfe, there may bee 2 dyametres diſcouered betweene the Naue and the Fellowes. There muſt be 12 of theſe Spoakes in each wheele, each one quarter of a dyametre ſquare. The Axtree muſt be 1 dyametres $\frac{2}{3}$ in thicknes. The Armes thereof ſhall be in the thickeſt place one dyametre, and at the ends thereof $\frac{2}{3}$ of a dyametre in thickneſſe. And at the place where it pierceth the Lymbers or ſides of the Cariage, it muſt be 1 and a quarter in breadth, and $1\frac{2}{3}$ in height. As by the figure 19 β may appeare, wherein alſo the places where the Mortis for the Tranſomes, Axis, and Trunions, are marked with *A B C D E F.*

And for further explanation of that which hath beene already ſaid, I will here ſet downe the particular proportions vſed therein for the whole Culuering, wherein the meaſures for the reſt may the better be vnderſtood: Firſt, for the *Culuering*, the Cariage ſhall be once and a halfe of the length of the Peece, ſo that if the Peece be 32 dyametres, the Cariage ſhal be 48 in length, and the Wheeles 11 dyametres high. The Naue 4 high and 5 in length, the Spoakes 4 beſides the one halfe let in at each end. The Fellowes two and the Arming one. The Axis ſhall be in length 13 dyametres $\frac{1}{3}$, and at the cutting of the Cariage therewith to bee 2 in breadth, and 2 in thickneſſe. The Limber Planks or ſides of the Cariage muſt be 4 and a halfe, or 5 dyametres broad, one thicke, at the Trunions 4, and at the Tayle 2 and a halfe; the reſt may be conceiued in the former figure 19, made for the Cannon.

Now to make the Cariage for the Demi-Cannon or Demy-Culuering, you may add to their former proportions $\frac{1}{12}$, ſo that inſtead of one dyametre

let $\frac{25}{34}$ be placed, which proportion ſhould be conſtantly held in all the meaſures propounded.

The like may be ſaid for the Saker and Minion, in ſtead of one take $\frac{13}{12}$, and for the Falcon for one take $\frac{7}{6}$, and for the Baſe, &c. in ſtead of 1 take $\frac{10}{8}$. And ſo theſe meaſures being neceſſarily added, may ſuffice, as well for gracefull ſhew, as vſefull ſeruice.

CHAP. LXI.

Of the making of Candleſticks and Blinds, and of great Sauſſons and little Sauſſons, and little Saucigdes, and of the inuentor and ſeruice of them firſt vſed at Oſtend. For hiding of Ordnance and men behind them, and to fill watered Dykes to approach a Breach.

THe Candleſticks are made in the forme deſcribed in the next figure 15 at *y*, and are of ſuch height, as being cloathed with *Blinds*, of Canuas, Sedge, or ſuch like light things, they may behind them couer and hide thoſe that worke in the *Trenches*, or labour in *Batteries*, hauing the one Poynt or *Piramis* diſtant frō the other in ſuch ſort, that 2023 Saucidges, or more, or Bauins, or bundles of Sedge, may be placed betweene them one by another, but of what wood it ſhall be beſt, is not fit to appoint, ſeeing that if it be good, and ſound, and light with all, to tranſport with them, ready cloathed from place to place.

Theſe *Candleſticks* are very neceſſary to make Blinds of proofe, as were ſeene at the Siege of *Oſtend* in *Buckuoy* his Ramparts, where his double and great Saucedges were not alone able to couer the Fabrick.

They may alſo ſerue in ouertures of *Trenches*, or in paſſing ouer *Dykes*, as was practiſed at *Rhinberg* in the Spaniſh quarter. They being by experience found to be ſingular good, eſpecially in myrie places, in which reueſting them with Faggots, and ſetting them accordingly, men may paſſe by without any danger.

As for the *Blinds*, although their inuentor be not knowne, it being an olde deuice, yet are they of ſingular vſe, to couer for a while, and to hide our workes from the Enemies ſights. They are repreſented in the next 15 figure alſo at *β*: For them certaine Stakes are pitched in the ground mans height, as bigge as a mans legge, in number, according to the diſtance, as the couerture that is to be made requireth. being placed 4 or 5 foote one diſtant from another, enterlacing them with the longeſt bowes can be gotten, binding them cloſe together. By meanes whereof, in one halfe day halfe a Champion may as it were be ſo couered, and all the Labourers therein hidden: As was experienced at *Oſtend*, and in the Iſle of *Bommell*: beſides, that they alſo ſerue very commodiouſly for couertures of Batteries, and very commodiouſly

16
30
DEC

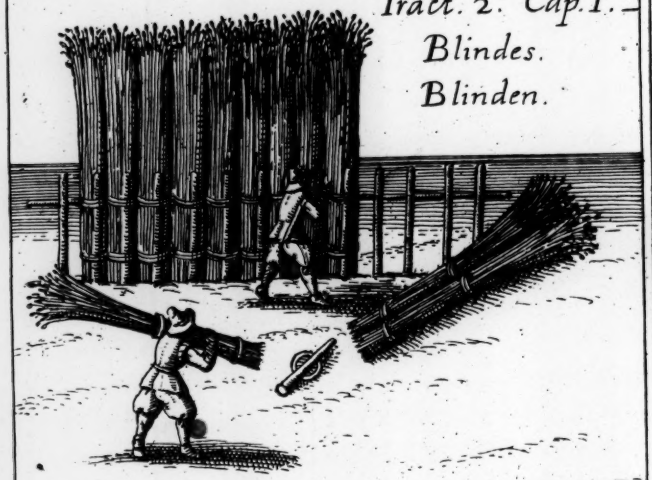
Saulsisson
Salsitzen

Saulsisson
doppel Saul-
sisitzen.

β

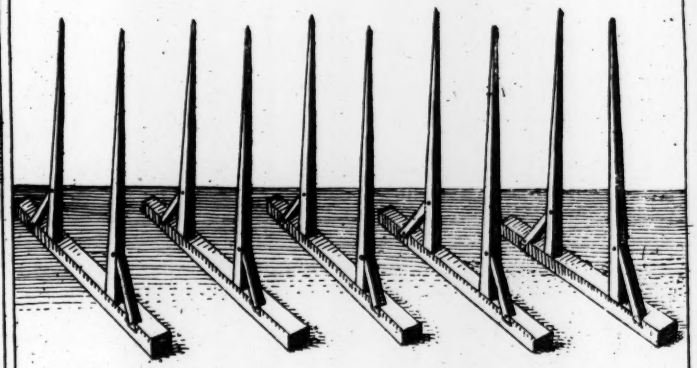
Tract. 2. Cap. 1.

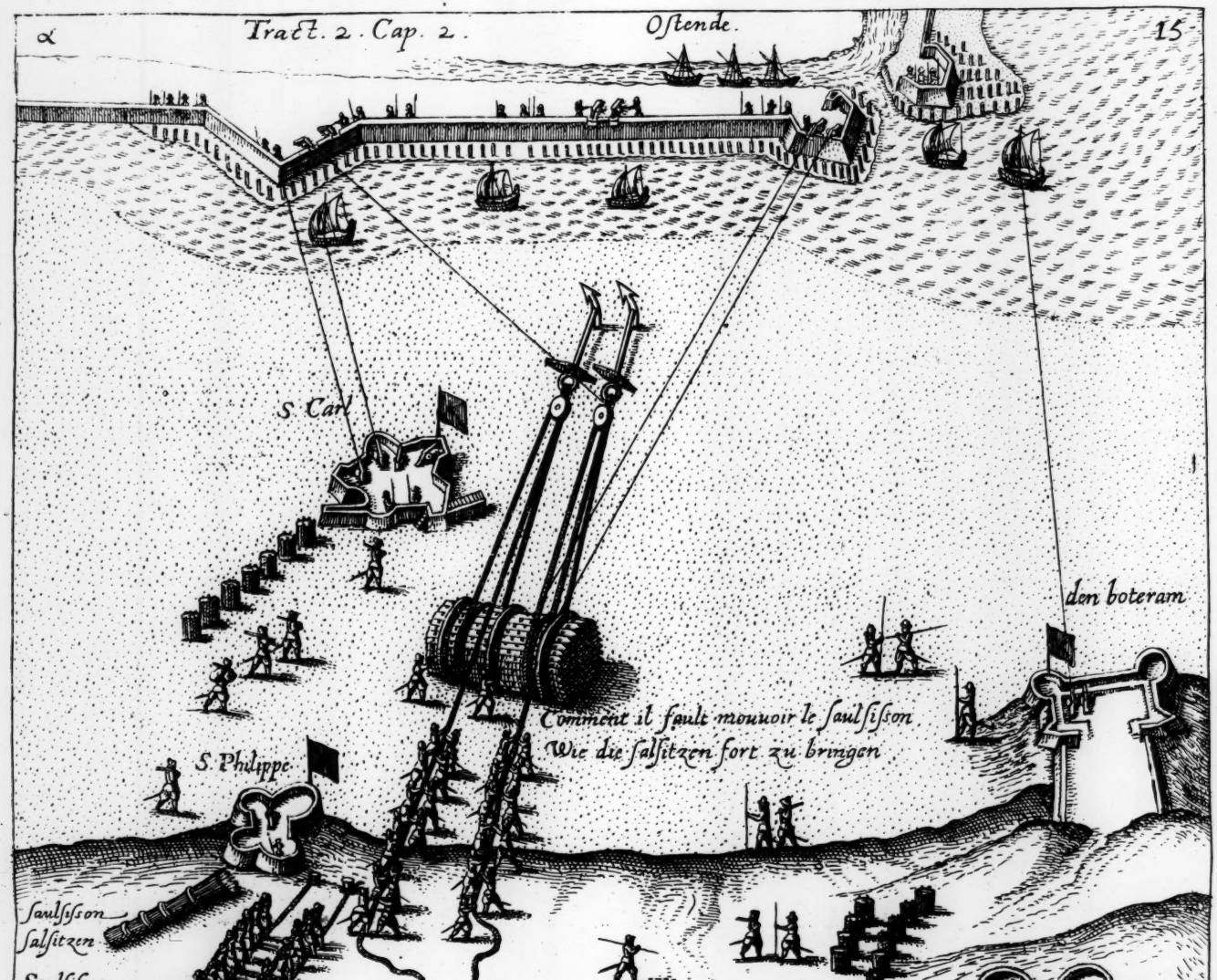
Blindes.
Blinden.



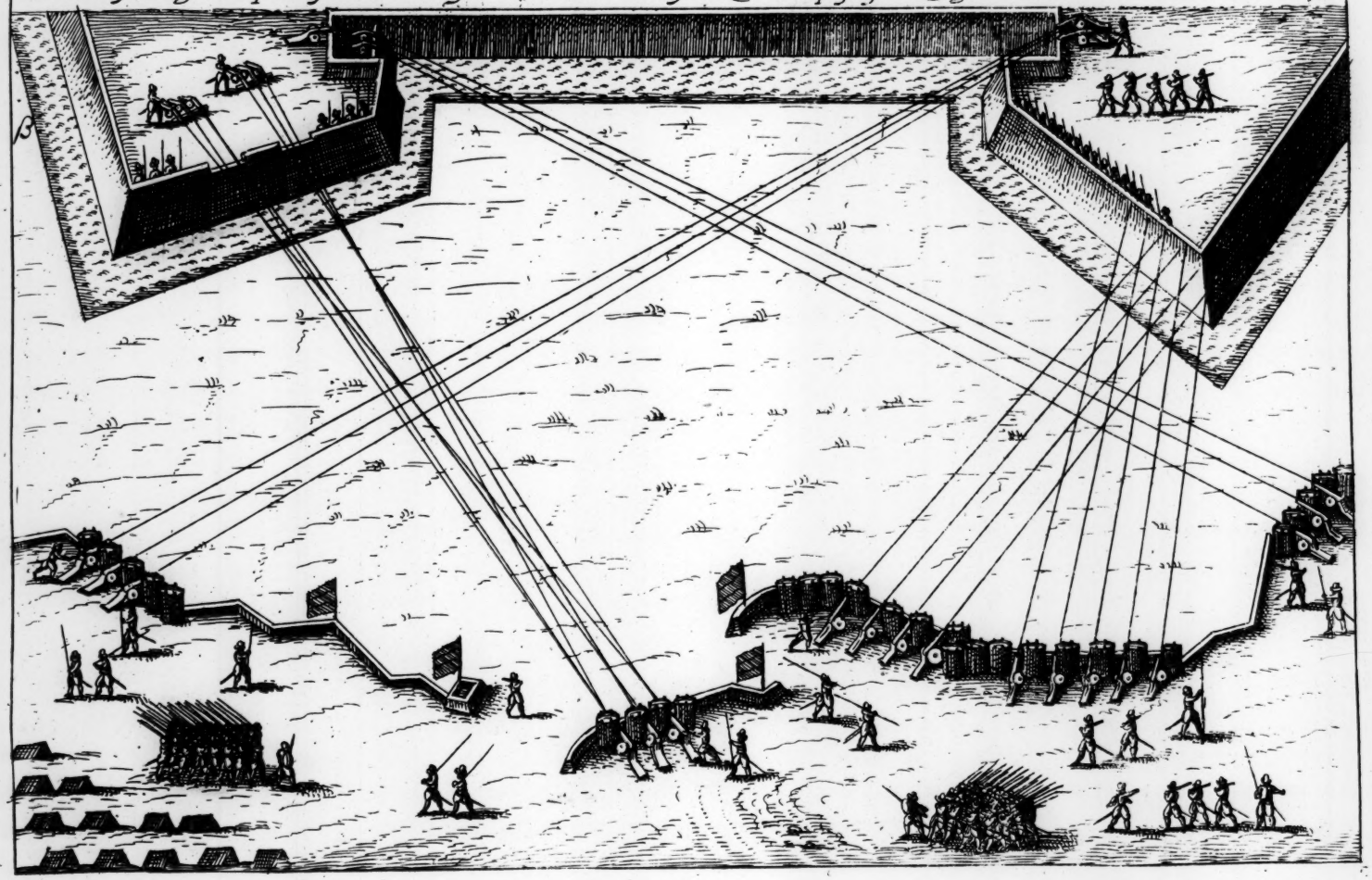
γ

Chandeliers. Leuchter.



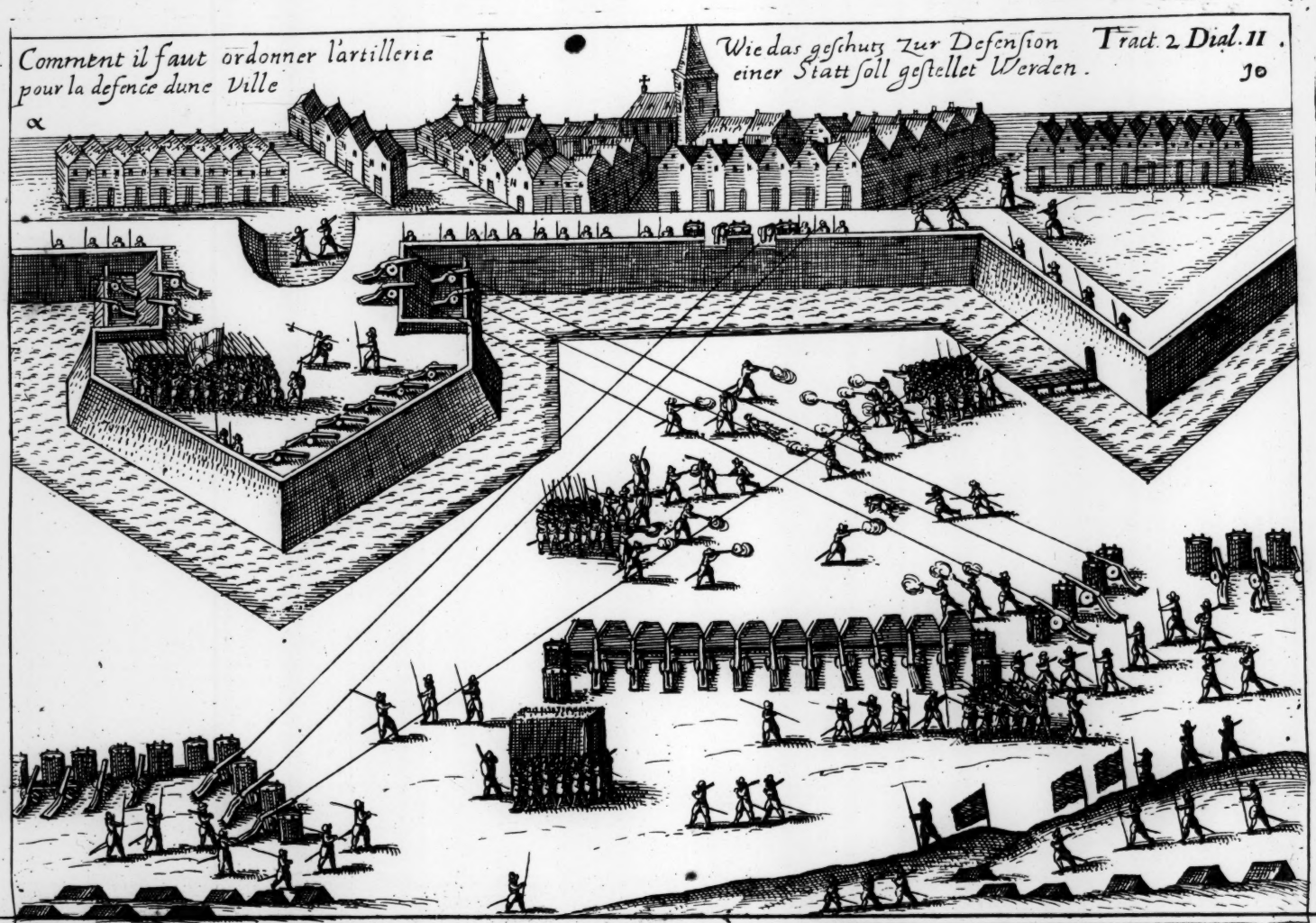

α
Tract. 2. Cap. 2.
Ostende.
15
S. Carl
don boteram
Comment il faut mouuoir le saulsisson
Wie die salsitzen fort zu bringen
S. Philippe
saulsisson
salsitzen

Comment il fault loger des pieces secretes en vn bastion. *Wie heimliche stuck in einer pasteyen zu gebrauchen*



Comment il faut ordonner l'artillerie pour la defence dune Ville

Wie das geschutz zur Defension einer Statt soll gestellet Werden. Tract. 2 Dial. 11. 10



Comment il fault loger des pieces secretes en vn bastion. Wie heimliche stuck in einer pasteyen zu gebrauchen Tract. 2. Dial. 17.

diouſly (for water-works) *Saucedges* were firſt made ſmall, inuented by one *Adrian Heranſon*, one wel experienced in making of *Dikes* and *walls*, and ſuch defences againſt *Water*, who both made alſo *Field Sauſedges*, which are ſingular to breake the violence of ſtreames of *Water*, to ſtrengthen Dykes, make Walls, and other ſuch like buſineſſes. After which, one *Chriſtopher Propergenius* perceiuing, that many *Sauſedges* ioyned faſt together, would make a great *Sauſedzion*, but to little profit, becauſe the exceſſiue bigneſſe thereof would not yeeld them meanes to moue it, vntill the *Count de Buquoy* diuided it, and thereof made 2 *Saſedgeons* better to be mannaged, whereupon they were afterwards vſed to reueſt *Candleſticks* as wee ſaid before. They were firſt made 46 foote long, and 15 foot dyametre, but were after brought to 23 foote long, and 12 foote euer-filled within with *earth*, and if to ſinke with *ſtones*, and in diuers places, as 3 at leaſt bound firmely together with yron Hoopes, and rowled to the places of vſe and ſeruice, or elſe with two Pyles or Anchors, Hawſers, and Blocks or Pullyes drawne thither by men behinde them, as in the ſaid 15 figure at α is repreſented to the eye: whereby an approach may be much the more ſafely expedited.

CHAP. LXII.

How to plant Peeces of Ordnance in ſecret Batteries, and in double Batteries, ſo that they may not eaſily be diſmounted by Counter Batterings.

IF the Peeces appointed to make a *Batterie*, be planted vpon a plat-forme that deſcendeth behind, that in their reuerſes they may goe vnder the vawmure of the *Tronier*, the *Troniers* being vaulted, as in the Caſſamattes at the 157, and 158 figures of *Marlois* is repreſented, they muſt by ſtrength and by Tackles bee brought vp againe aboue the vawmure of the *Tronier*, and the ayme to bee readily taken before the *Tronier* be opened, and fire giuen immediatly after the inſtant of opening it: So will they in their Reuerſes be againe got vnder the vawmure, and bee free from diſmounting, ſo long as the Furne mouth & Vawmure is able to keepe from the ruine of Counter-batteris.

There is alſo a meanes to ſaue Peeces from being diſmounted, namely by ſuch double defences as are repreſented in the 22 figure β, with ſuch *Battlements* or Loopes as are there vnderneath repreſented, then onely obſeruing that they be of equall wideneſſe, both before and next the Peece, and to make them equally deepe enough, ſo as the right line that may diſcouer the Enemies Peeces, lye right through each Loope one, then 10 foote more backward or forward, make ſuch another Batterie: As the ſaid figure will ſufficiently demonſtrate, ſo by thoſe two ſeuerall Loopes the Peeces will be

ſo ſurely defended and hidden, that the Enemie ſhall very hardly diſcouer them, much leſſe ſhoote ſo preciſely, as to diſmount them through both.

Chap. LXIII.

How to plant Ordnance, whereas the Rampart is too ſhallow for their Reuerſe, and where earth is wanting.

FOraſmuch as ſuch neceſſities may often happen, it will not bee amiſſe to ſhew how to ſupply the ſame when neede ſhall be: Firſt, for each Peece take 6 Trees, high enough, ſtrong, and ſtraight; if 6 be not ſufficient, take 9 or more for each Peece, which driuen deepe enough into the ground to hold them firme, and making each of them ſtrong to carrie their burthens with Braces, Ioyces and Plankes, making thereon a Plat-forme 20 foote long, and of ſufficient breadth, that the Peeces may both be mannaged thereon, and alſo play and reuerſe freely, remembring that thereon a Peece will more reuerſe vpon this being leuell, then vpon a Plat-forme that riſeth behinde, and will therefore without ſufficient roome and care, endanger the Peece by her falling from aloft to the ground.

Chap. LXIIII.

How to make a Battery with Peeces enterred.

THis manner of Batterie hath long beene vſed both in *Italy* and *Hungaria*, whereof the delineation following is a ſufficient illuſtration, yet a word or two thereof: Firſt, you may marke out as much place vpon the ſide of ſome Hill or Mount neere, and raiſed of ſufficient height, as will ſuffice to receiue your Ordnance, ſo that they may each ſtand 20 foote diſtant from one another. And then by the ayde of *Pyoners* & other *Workmen*, make a *Dyke* deepe 11 foot, defenſible ſufficiently, be it forwards, artificially, or naturally, by thicknes, from the bank or out-ſide of the hill, to the inſide thereof, and ſo broad, as that people may paſſe behind the Ordnance, when they haue reuerſed. And when you haue made Plat-formes, open *Trauiers* or Loopes through the *earth* of the ſide of the hill, ſo high, broad, and deepe, as you would haue them, which is a way ſo ſure, that the Towne walls cannot any way hinder you therein, eſpecially if it be in a naturall firme mould of *Earth*, if the blowing of the Peeces cauſe any of the earth within the *Trunier* to fall, a long Colerake will ſoone draw out the ſame, and you may alſo line it with Watlings.

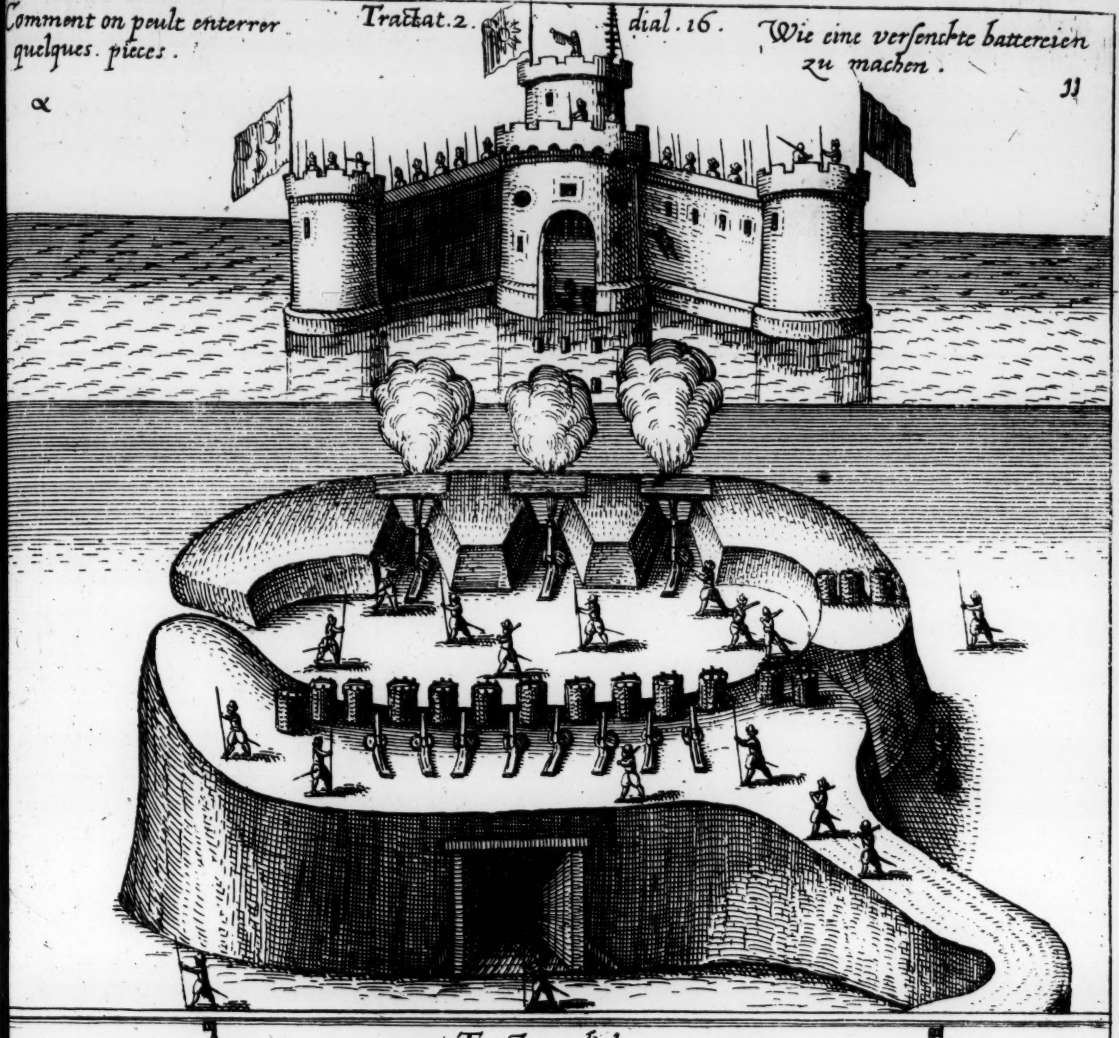
Chap.

Comment on peult enterrer quelques. pieces.

Tractat. 2. dial. 16.

Wie eine verſenchte batterejen zu machen.

α

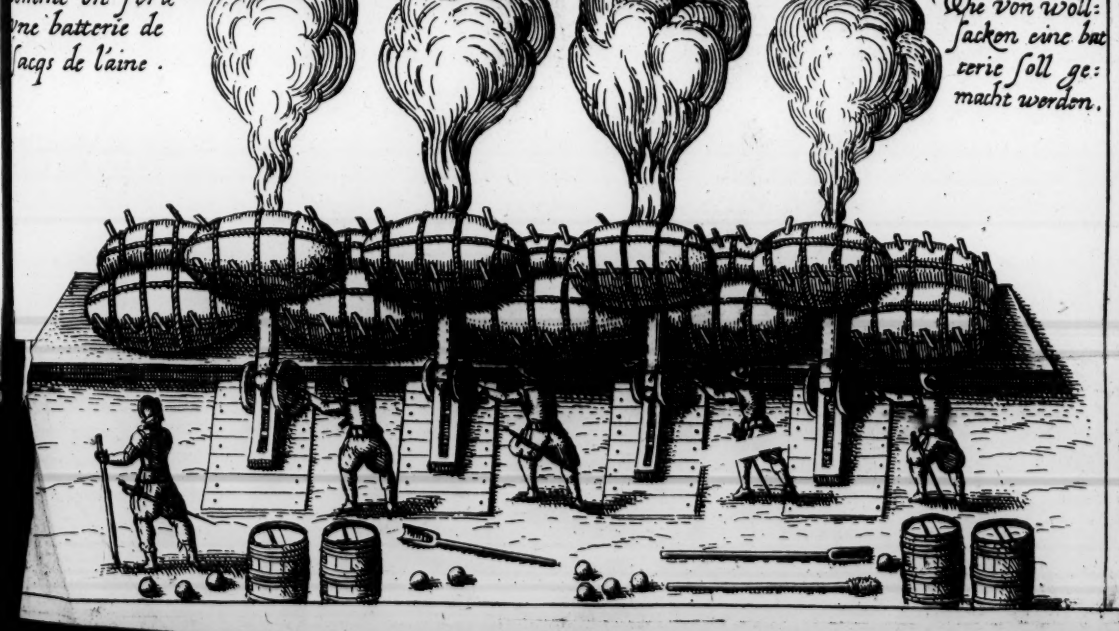


β

Tract. 2. dial. 15.

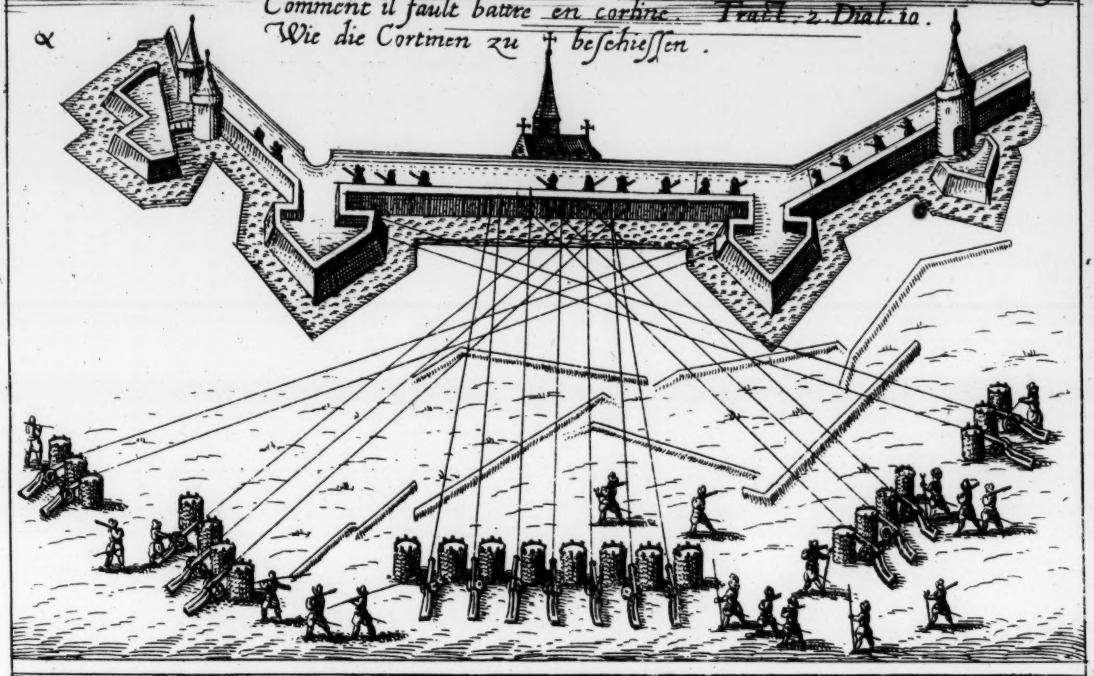
Comme on fera vne batterie de ſacqs de l'aine.

Wie von woll: ſacken eine bat terie ſoll ge: macht werden.



α

Comment il fault battre en cortine. Tract. 2. Dial. 10.
Wie die Cortinen zu † beschiessen.

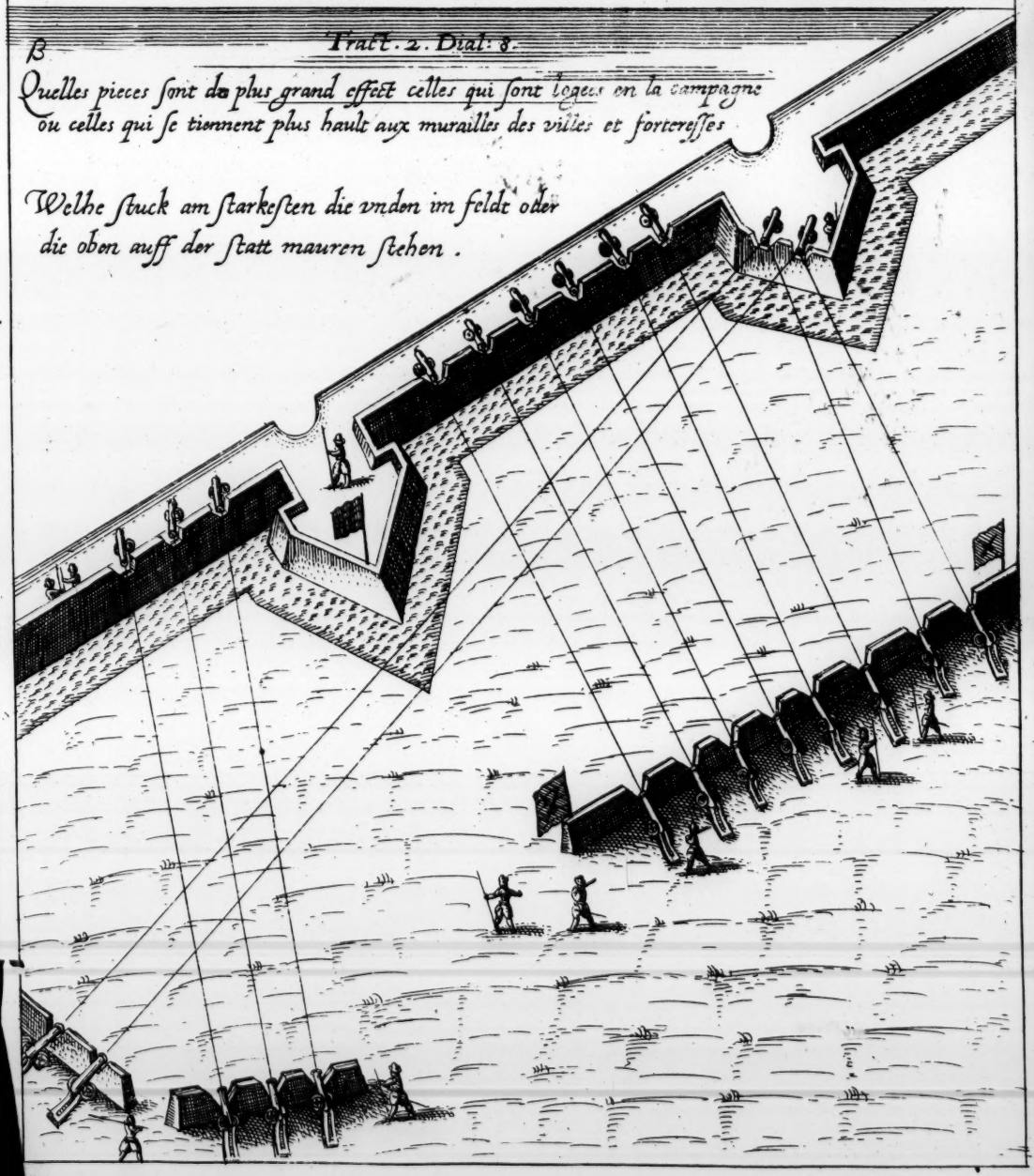


β

Tract. 2. Dial: 8.

Quelles pieces sont de plus grand effect celles qui sont logees en la campagne ou celles qui se tiennent plus hault aux murailles des villes et forteresses

Welche stuck am starkesten die vnden im feldt oder die oben auff der statt mauren stehen.



BRITISH MUSEUM
1880
DEC

Chap. LXV.

How wanting all other meanes, to make a Batterie by Woolſackes.

WHere none other but grauelly *earth* is to be had, there to auoyde the ſhottering, that the *Enemies* Ordnance may make by the ſtones, to endanger the Camp, Woolſacks, may make the Sholders and *Troniers* in ſuch manner, as this figure 11 is repreſented. This is no new inuention, for it hath long beene vſed by diuers Nations: now it were neceſſary that theſe Sacks were 17 foote long, and 7 foote thick: And to reſiſt the Cannon, there ſhould be three in breadth to make the Shoulders or Parapets of the *Troniers*, and for the Demy-Cannon 2 and a halfe: And it is to bee vnderſtood, that the two outmoſt of the three Sacks, muſt be ſomewhat ſhorter then that within, to giue ſufficient ouerture for the *Troniers* without, that the blowing of the Peeces endamage them not, vpon the ſaid ouerture 1 or 2 Woolſacks ſhould alſo be layde to ſerue in place of *Blinds*, for the trauerſing and mannaging them the more ſafely: if by chance the Sacks doe any where take fire, there muſt be water and earth ready to quench the ſame; and to faſten theſe *Woolſacks*, they muſt be Pyled with Pyles driuen into ground, all firmely bound together. Alſo if other Ordnance then the *Cannon* or *Demie*, there muſt be as many more Sackes of Wooll for ſhoulder defences, as that all the Peeces may bee well couered: as the vndermoſt of the 11 figure next manifeſteth.

Chap. LXVI.

How to place great Ordnance, both to diſmount the Enemies Artillerie, as alſo how to make a Batterie on the Curtin of the Place, and when.

ALthough it hath beene a receiued opinion, that ſuch Peeces as doe lye high on the walls, are in leſſe danger, and haue more aduantage then ſuch as are alowe in the Champion plane, becauſe thoſe aloft may more eaſily diſcouer thoſe alowe then the contrary. Yet it is found otherwiſe by experience, as in the 9 figure is ſeen, wher the Peeces alowe, playing alwayes vnder the Peeces, aloft, doe and may well embouch them, or elſe not faile to cloy their Plat-formes, or beate their Cariages Wheeles and Axeltrees, and ſo conſequently make them vnſeruiceable, beſides that if they take them

vnderneath, they often diſmount thoſe aloft, whereas thoſe aloft cannot diſmount thoſe alow, for if a Shott ſhould light vpon the vpper part of the Mettall of a Peece lying vnder it, it will but glance away with little danger of diſmounting, whereas if a Shott light vnder a Peece from alow, it either dangereth the diſmounting thereof, or elſe the tearing of ſome part of her Cariage or Wheeles.

Now for that the charge of making Batteries is great, it requireth good husbandry ſhould be therein vſed, and the coſt not vainely ſpent, for thereby will acrew encouragement to the Enemie, and diſcouragement to the party. Beſides, therein the Scyte and poſition of the place beſieged, is to be well conſidered before it can be reſolued, which is the beſt way, either to beleaguer or place the Battery thereunto: For a Place may be aſſaulted in one place, and yet battered in another, and ſometimes the Batteries are to be made vpon the poynt of the Bulwarkes, and ſometimes vpon the Curtins, euer ayming at victory, the end of the enterprize vndertaken. To batter a place well manned, as Forts and Caſtles, at the Bulwarks and Caualeriaes is beſt, being places of defence: But in a Towne hauing cloyed their Caſſamats and defences, the Curtin is fitteſt to be battered, becauſe it requireth more entrenchment, and is of leſſe force in the Terraplenes thereof. *Graue* and *Tranſont* were battered vpon the Bulwarkes, and *Cort* and *Cambray* were battered vpon the Curtins, and ſo each gotten, wherein the beſt oportunity, and way is to be taken, to obtaine the deſeigne. And for battering a place vpon the Curtin, 18 Peeces will be neceſſary, namely 8 Cannon, 6 Culuerings, and 4 Demy-Culuerings, placed as in the figure 9 at *a* is ſhewed, wherein the 8 Cannon playing at right angles, they are to ſhake and batter, by reaſon of the waight of their Shot, the Culuering play trauerſly, and to cut out that which the Cannons haue battered, and the Demy-Culuerings to play vpon the Flankers and defences, as alſo to hinder the Sallyes of the beſieged, and diſcouer and diſmount their Ordnance. The diſtance that a Battery for either ſhould be made, ought not to be aboue 120 paces, or 150 at the moſt, or at 80 or 90 paces if poſſible, the leſſe the better, yea though it were at the edge of the Dyke, for the neerer they are, the greater are their forces: ſo as the Ordnance may be couert, that the Gunners and Matroſſes may be without danger of Musket ſhott, which is beſt at 80 or 100 paces, if you may conueniently approach ſo neere.

Take this by the way into remembrance for a note: That a Cannon at 120 paces, will pierce a wall or Rampart meanely ſetled 15 or 16 foote, and being well ſetled onely 10 or 12 foote, but in cloſe ſandy ground 20 or 24 foote deepe. And that a Cannon may being well fortified, and duly and diſcreetly mannaged, be diſcharged 100 times in one day.

Note alſo that a Cannon with one ſhot made well and orderly, will ruine more then 100 Hods of *earth* can repaire: For one man can carie but 100 Hods of earth in an houre, the diſtance of 130 ſteps, or not much more.

Further, you may note that 1000 Shott ſuccinctly made out of 10 Cannons, will ruine more then 1500 Shot can doe, being made out of 5 Cannon. And leſſe can the Enemie repaire the firſt, then the laſt: For a Cannon Shot made euery eight part of an houre at 100 paces diſtance, will make as much ruine as 12 men, can keepe in repaire.

But

16
30
DEC

α

Tract. 2. Dial: 18.

Comment il faut loger l'artilleria pour Battre la pointe dun bastion et les defences qui sy peuent faire.

Wie das geschutz zur beschiessung einer Pasteyen zu stellen. vndt. Wie man sich Darinn Kann Verschantzen.

β

Comment il fault loger des pieces et les esleuer a faulte de terre.

Tract. 2. Dial. 14.

Wie man im mangel der erden auff einen gerust erheben soll

But if 12 Cannons be well imployed in a Battery together the 96 Shott, that they may make in one houre, will ruine farre more then 144 men can keepe in repaire.

For 14 Cannons will ruine more then 12 and 16 more, then 14 ſpending, but the like quantity of Powder and Shot. Therefore Ramparts ought to be augmented in thickneſſe, according to the Batteries made, but not in proportion, becauſe the inner part of a Rampart ſuffereth not ſo much, nor is it ſo eaſily ruined, as the fore-part thereof may be.

CHAP. LXVII.

How and when to make a Battery vpon the poynt of a Bulwarke, and of the defences to be made therein.

WHen and where the Curtins are ſhort and cloſe, the Battery is to bee made vpon the point of the Bulwarke and *Canaleriaes*: But then it requireth as many or rather more Ordnance then before for the Battery of the *Curtin* was appointed. The 8 Cannon to beat about the point of the Bulwarke, the ſixe Culuering trauerſing more at right angles with the Front thereof, and the foure or ſixe Demy-culuerings to play vpon the Caſſamats, on each ſide 2 or 3, and they are alſo to attend other occaſions that ſhall happen, as hath already beene ſaid, and as the figure 12 at *a* repreſenteth together, with ſuch retrenchments and defences, as the beſieged may or ſhould make, being forced, of which there is no danger when the Battery is made in the Curtin, wherein the Breach being once made, it may bee more eaſily forced without any other dangers then thoſe of the Bulwarkes and Caſſamats, which are not onely farre off, but alſo to bee cloyed or diſmounted afore-hand, or elſe they are oppoſed and encountred with the Demy-culuerings, and other Peeces placed on the brinke of the Dyke, eſpecially where neceſſity will vrge, or occaſion require, whereas in the Curtins there can hardly any ſuch retrenchments bee made, as in the Necks of Bulwarks, where with halfe Moones, in the neck thereof, they may make new reſiſtances with a few men, the Bulwarke being Myned, and the Towne imagined to be gained, yea when fire ſhall bee giuen to the Trayne, which may be perchance preuented alſo by countermynes, which cannot be ſo directly directed on the breach of a Curtin, as on the Bulwarke whoſe necke is narrow, and may ſoone be defended, and retrenched with leſſe labour, time, and force, and cauſe the aſſaylants to preſent more men in danger of blowing them vp by the Enemies Mynes.

CHAP.

CHAP. LXVIII.

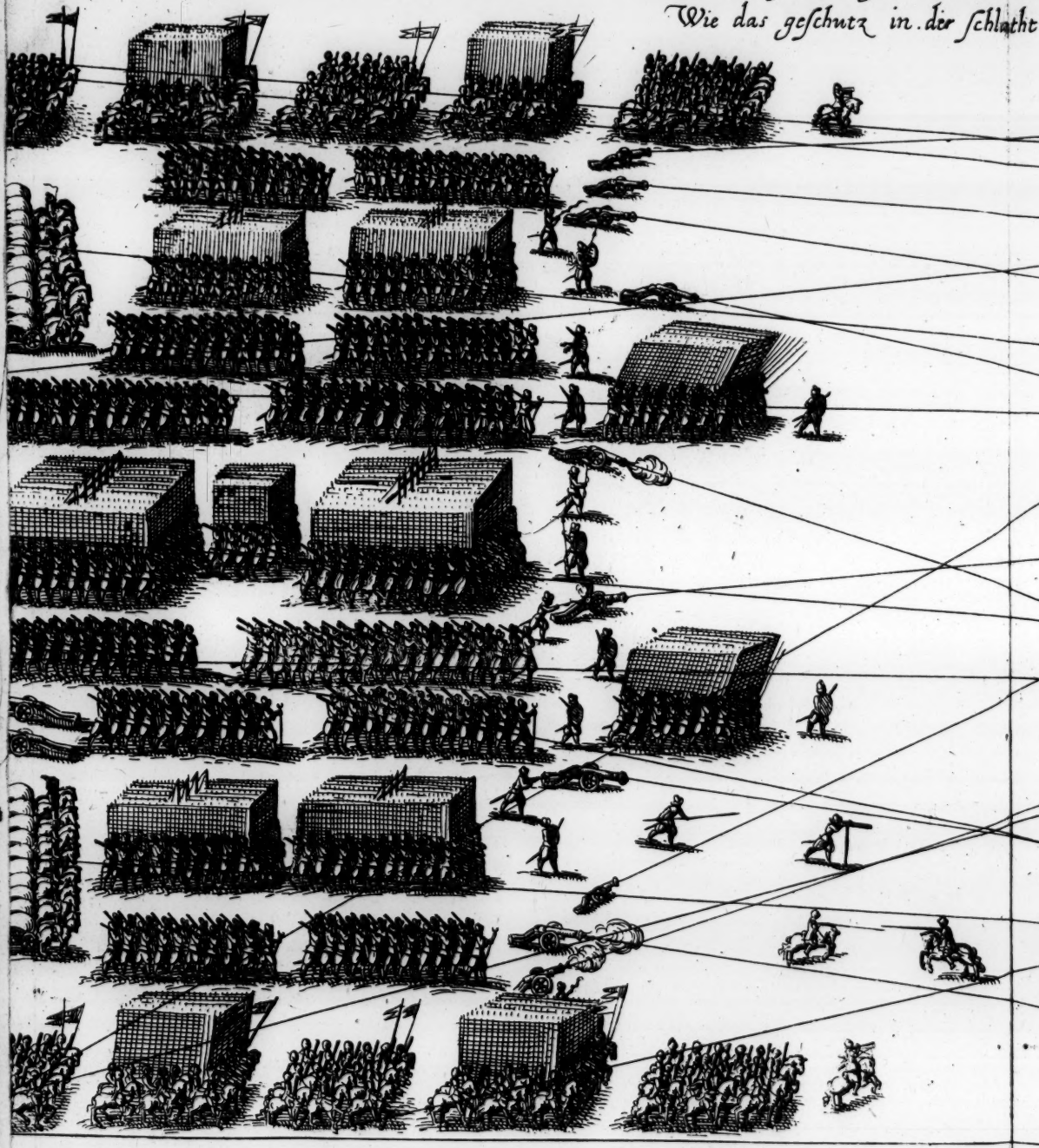
How the Ordnance are to be placed at the houre of ioyning of two Armies, to offend the Enemie moſt.

THis is a poynt hard to be handled by me that haue not ſeene many Armies meete; but finding ſeuerall opinions deliuered by others, I haue thought fit to recite them, & deliuer what to me ſeemes moſt reaſonable, leauing each to chuſe either of them, or any other way as to him ſhall ſeeme moſt fitting. Some ſay that the Field Peeces ſhould be placed in the Front of the Bands, and ſome that they ſhould be placed trauerſly two and two, or three and three together, on the ſides or flankes in the forme of the *Muskatiers*, couered with the wings of the Horſemen. But it ſeemes to mee moſt expedient, that certaine Peeces ſhould be placed in the Front, which may endomage the Enemie on all ſides, ſeeking alwayes the places of moſt aduantage, without danger of looſing any of their Ordnance, and certaine Peeces alſo to be placed in the Flanke, ſome to ſhoote forth-right, and ſome a Trauers, each 3, from other diſtance 50 or 100 paces. And then there is no more danger but in the ioyning to withdraw the Ordnance, that our Ordnance hurt not our owne bands: And that they be alwayes ready to be Trauerſed, and retreated, as neede ſhall require, which may much conduce to victory: But it will ſeldome happen, that in a Battaile there be ſuch places ſo commodious to be found as were to be wiſhed, for that moſt commonly we ſhall be conſtrayned to conforme our ſelues, according to the preſent occaſions, as woods, hills, and other vneuen places, for which no other rule can be giuen, but with great iudgement to ſeeke how to get the aduantage of the Enemie, without being offended by Sunne, winde, or duſt, and ſuch like, which though they may be thought to be ſmall things, yet they will bee therein found to be of great importance. But I cannot be of their opinion to haue all the Peeces on the ſides to be beſt, for ſo the Squadrons meeting, ours ſhall be more offended thereby then the Enemies, beſides, that thereby this great danger will ariſe, that when the wings of our Horſemen would be willing to aduance ſpeedily, they will be greatly troubled with thoſe Peeces ſo ſhot out of the ſides: wherefore the Generall, or Maſter of the Ordnance, or his Lieutenant, conſidering theſe things, muſt giue directions how the Ordnance ſhall be lodged, either all in Front, all in Flanke, or ſome in both.

16
30
OEG

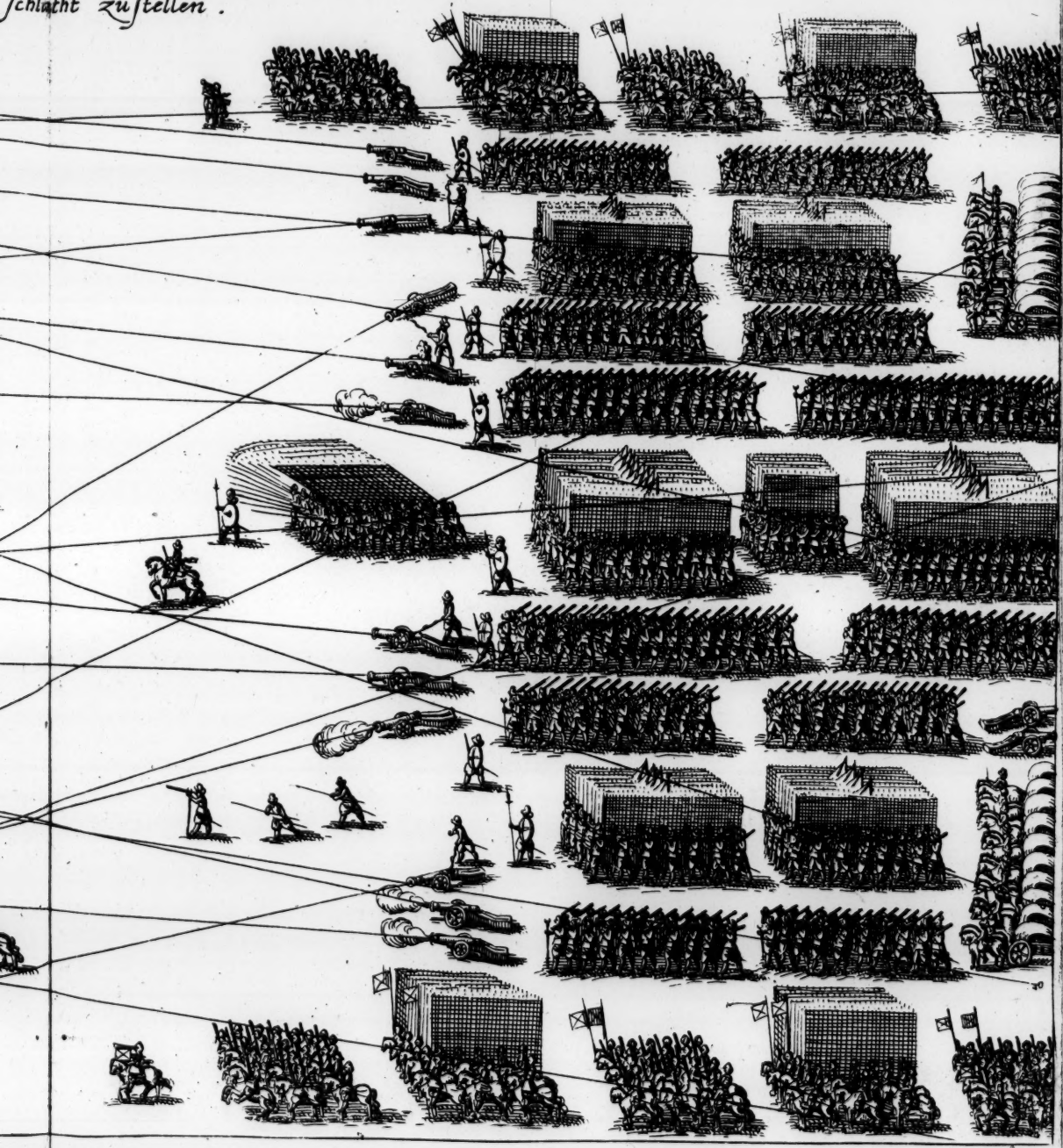
Comment il fault loger l'artillerie a

Wie das geschutz in der schlatht



illerie au poinct du Combatt . Dial. 5. 8

ſchlatht zuſtellen .



BRITISH MUSEUM
DEC

Chap. LXIX.

How to fill vp a wet Dyke, whereby to approach the Breach made.

HAuing already ſhewed how a Battery may in diuers ſorts bee made, and alſo how to make the Breaches ſufficient for entery, we will now ſhew likewiſe, if the *Dyke* ſhould be deepe, and full of water or mud (that the Souldiers are thereby hindered) how the ſame may beſt be filled vp. Wherefore, although there be many wayes to performe the ſame, yet this in my iudgement is the beſt; namely, that when a ſufficient *Breach* is once made, that then the *Approaches* be alſo immediatly made vnder the couertures of the *Trenches*, euen vnto the edge of the *Dyke*, and then with Faggots, and *earth*, or *Sauſedges*, (whereof we haue ſufficiently ſpoken already) to fill it vp, hauing the benefit of the ruines that the *Cannons* haue made of the *Wall*, and Faggots, and Sauſedges which cannot be wanting, whereas either Gardens, Trees, or Woods are neere hand. Or elſe if great Trees be throwne into the Dyke, if they ſwimme, being of Firre or dry light wood they will, then Plankes layd vpon them (the Dyke being exceſſiue deepe) and on each ſide of ſuch Floats, blinds being raiſed to hide the Paſſengers from ſight of the *Flanker*, they may thereby paſſe to the foote of the *Breach*, euen as by a *Bridge*: But ouer a ſmall Riuer or narrow *Dyke* a Bridge may be made ouer vpon a *Boates*, as in the 17 figure at β is repreſented. But being firſt well informed of the quality of the *Dyke*, whether it be of ſtanding or running water: If it be ſtanding water, then a dozen of light Float *Bridges* will helpe well; if there be any ſcarpe on the other ſide, or elſe they are worth nothing: But in ſted of them *Floats* being made with two Fir poles or light wood ſtrait about 15 or 20 foot long, about the thicknes of a mans legge or thigh, vpō which two ſides may be nailed croſſe-wiſe ledges or boords of wood, about 3 foote long all along vpon them. And ſo theſe may each of them be caried by 6 men; namely 4 at the two ends, and 2 at the mid ſides, as a corpſe is vſually borne to be buried. And at both the ends of thoſe two ſides, there muſt ropes be faſtned, by which heſe floating bridges ſhall be lanched, and drawne from one ſide of the *Dyke* to the other, foure or ſixe Souldiers being gotten vpon it, reſting them vpon their Pykes, which being landed and paſſed ouer: the Souldiers on the other ſide may draw, bake the Float by the ropes at the end next them, and then 4 or ſixe more may get vpon the ſame, and the Souldiers already landed, may draw them ouer by the ropes at their end, and ſo helping one another from ſide to ſide, many men in a little ſpace of time will be tranſported ouer. And when as there are a competent number gotten, or the Floats drawne vp, may ſerue for ſcaling Ladders, or to mount the Breach the better by. But if for the walls theſe Ladders or Floats be too ſhort, there may at one end of each ſide be two loopes of Iron faſtned, and ſo firmely fitted, that the two other ends of another Float or Ladder may fitly enter thereinto, and ſo two or

moe shall make one Ladder, vntill they be found of sufficient length. And lastly, we will remember you of Ladders, of Cords, or Ropes, with wooden steps like entering, Poope Ladders in Shippes, hauing an yron Grapnell to throw ouer the wall, to hold fast on the Vawnure or Parapet.

CHAP. LXX.

Of the Gunners seruice in generall.

NOw forasmuch as Ordnance are Engins of force, reason, waight, and measure: and the Gunners men exercised and experienced in them, and their apurtenances in making plat formes, with defences, *Troniers, Gabbions*, Loopes, Parapets of earth, and Faggots about 23 or 24 foote high, of Faggots 2 foote high, of earth bed vpon bed vnto eleauen foote high, and after 3 foote of Terraplene, to raise the Troniers and Loopes, so that for the *Cannon* it be 3 foote wide in the Barb within, and 12 foote wide without, the lower part thereof to descend scarpwise, the better to discouer the *Enemies* auenewes, and offend them the more freely, for auoyding the blast, and smoake, and ruine, it would else make: For the *Culuerings* 2 foote and a halfe within, and 9 foote without will suffice; and for lesse Peeces, lesse measures. If the Battery be to be made with *Gabbions*, they being filled with earth without stones, moystened and rammed 7 foote a peece in dyametre, 3 rankes betweene each 2 peeces, if the place will permit, or 2 at the least, and 3 rowes also one before another, setting one betweene two; so if the first ranke haue 3, the second will haue 2, and the third one: But it will be hard to make a safe Battery with *Gabbions, Cannon*, or *Culuering* proofe: And each plat-forme is to haue 30 foote for the reuerse of the *Cannon*, and 27 foote for the Demy-Cannon, he ought to see that it bee leuelled, or rising 1 foote for 20 backwards, the better to stay the reuerse & facillite, the bringing the Peece being loaded to the Loope: He ought to search and examine the goodnes of the Peeces, their Ladles, Rammers, Spunges, and Tampions, fitnesse, and roundnesse of the Shot, force and goodnesse of the Powder and Match: And to see all fitted accordingly, and to place the Powder couertly, hid safe from the fire of his owne, as also of the *Enemies* Ordnance. To see the Gunners take their marks towards the vnder part, giuing each vnder Gunner his charge.

In Plat-formes, the first plank next the Barbe should be 9 foot long: the second 9 and a halfe; the third 10, &c. euery planke encreasing halfe a foote, to spread for the Reuerse, as may be seene at the first figure at *ß*.

CHAP.

CHAP. LXXI.

Of the differences of our Engliſh meaſures in Feete and Inches, from the Meaſures of other Nations. And alſo of thedifference of pounds and hundreds.

ALmoſt all Countries agree in this, that 12 inches make a foote, but the length of their ſeuerall inches doe commonly ſo much differ from one another, as whatſoeuer they ſpeake or write of Meaſures in feete and inches, muſt not without reducement bee vnderſtood, to agree with our Engliſh foote and inch of Aſſize, as the diſcourſe and Table following will make plaine, whereby it will appeare how little Forraigne tranſlations, without diligent and exact reduction, when they diſcourſe of paces, yards, feete, inches, or other meaſures, write they neuer ſo well and truly of their owne, can auaile vs.

For three inches at *Vienna* is 3 and $\frac{1}{10}$ of our *Engliſh* inches.

And 3 inches at *Venice* containeth 3 $\frac{1}{10}$ of *Engliſh* inches.

Two *Grecian* inches is 3 *Engliſh*, they hauing 8 inches in our foote, ſo their foote is equall with the *Engliſh* foote of Aſſize.

The foote in *Bauaria* wanteth $\frac{1}{10}$ of our inch of the *Engliſh* foote.

The foote of *Antwerpe* is $\frac{6}{10}$ of our inch, ſhorter then the *Engliſh* foote.

The foote of *Farara* is 15 $\frac{2}{10}$ of our *Engliſh* inches.

The *French* foote *de Roy* is one foote and $\frac{1}{10}$ of an inch *Engliſh*.

The *Tuſcan Braſe* is 23 *Engliſh* inches.

The *Florentine Braſe* is 22 and a halfe of *Engliſh* inches.

The *Breſsian Braſe* is 17 $\frac{1}{10}$ of *Engliſh* inches.

The *Canne* of *Naples* make 20 *Engliſh* inches.

The *Canne* of *Rome* make 22 *Engliſh* inches.

The *Millan Braſe* make 23 *Engliſh* inches.

The *Loraigne foote* is 11 $\frac{1}{7}$ of our *Engliſh* inches.

Whereby each man may iudge how much confuſion would haue growne to the Reader, that ſhould haue read a *French*, *Italian*, *Germane*, or *Spaniſh* Author, and had no meanes to vnderſtand, that there were any difference in length of the Meaſures of one ſame name. And the like may be ſaid of the waights vſed of ſeuerall Nations, which with the former of Meaſures, would not onely haue a double *error*, dangerous for practiſe, but alſo confounded the Readers that ſuſpected no ſuch thing.

The pound *Troy* being about 1 ounce and a halfe lighter then the pound Auerdepoyze, yet the ounce *Troy* being heauier then the ounce Auerdepoyze, becauſe *Troy* hath but 12 ounces, whereas Auerdepoyze hath 16 ounces in the pound. The Kintall of *Biſcay* 150 *l.* is but 124 *l. Engliſh*. And the great Kintall of *Portingall* 128 *l. Engliſh*, the leſſer Kintall is 112 *l. Engliſh*.

The hundred ſubtill or ſmall hundred, is 100 *l.*

The great hundred is 112 *l.*

One pound *Troy* waight is 13 ounces 4 *d.* waight, 19 *gr.* $\frac{11}{19}$ of a graine of the Hauerdepoyze waight. By these are all their Ordnance and Munition waighed: But in seuerall Countries they differ, as you may see in M. *Records* booke of Arithmatick, called *The Ground of Arts*, whereby the Reader may iudge how necessary these differences are to be knowne, and that reduction should be duly made least confusion follow.

CHAP. LXXII.

Of the making of Salpeter, whether it be Naturall or Artificiall.

Salpetre is a body of Ayre, transformed into Earth, apt by Moysture to be dissolued, and by Fire to be resolued vnto his first state Ayre, being an Ayrie substance, fixed in dry Earth, dissolued by Water, and concocted by Heat into a solid substance, and accepted the rich Mine of Princes in this Warlike Age, and by Philosophers accounted a quintessence of Qualities, participating of all, and yet simply no one of them: For being sharpe and salt, in Taste hote and dry, it enioyeth the quality of Fire, and being also hote and moyst, easily dissolued into Water, and by fire resolued into Ayre, appeareth to be Ayre it selfe: And being white and cleare cooleth warme Wine in hote weather, being dissolued, and a vessell therewith put therein, it approacheth neere Water, colde and moyst: And being, it will bruse, and be brought, or be molten into a hard stone: it is also colde and dry of the quality of the Earth, enioying all the qualities, and a conuertible to all the *Elements*. It so becommeth as they say a *quinta essentia*. *Salpetre* is of two sorts namely, Artificiall and Naturall. The Naturall Salpetre is that which groweth in continued Mynes of the Earth, or vpon Rockes, or in Vaults, on Walls, and by Natures worke becommeth perfect Salpetre, whereof the store is to small too depend vpon. The Artificiall Salpetre (though naturally growing) also requireth the helpe of Art to bring it into true and perfect Petre, and is found in so many places, as in Loame-Floores, Mud-walls, Sellers, Doue coates, Stales, Stables, and such like places, whereas the rayne cannot come to dissolue, nor the Sunne to dissolue the Ayre, substance, fixing and growing therein, that with labour and industry with Arts helpe, to cause aboundant procreation, sufficient store may be prouided, and Artificially made thereby in this manner. First, for choyse of the Earth for finding, it whether sufficient quantity of Petre be therein or not, obserue this, Pare the Floores, and digge 3 or 4 inches deepe therein: if you finde the Earth full of white and yellow specks, and that hauing put a little thereof vpon the top of your tongue: it it yeeld an Ayrie biting, or sharpe tindge thereon, the Earth is good, and will be rich, and yeeld store, according to the more biting or tindging taste thereof. Then digge that Floore so deepe, as you finde

finde the Earth to be good, which in some places will be a yard, and in others not a foote deepe, vnder the vpper Floore make the Earth somewhat small: And put it into halfe Tubs loose, hauing a Taphole in the bottome of each, which stop with a staffe and couer, with a wispe, that the Earth runne not out, when the liquor drayneth. Then fill the said halfe Tubbs with water a handfull higher then the Earth, and so let it stand in soke 24 houres, and then draw out the staffe or pegge a little, that the water may drop and drayne out thereby into another halfe Tub that must be set vnder it of purpose to receiue the Liquor, which Liquor keepe, and lay the Earth vpon the Floore, which in six or seauen yeares will againe breed as much more Petre therein, and in some floores, especially with helpe, in farre lesse space. When you haue collected sufficient quantity of such Salpetre liquor (vnlesse you haue Mother liquor) you must of some of it make the Mothers thus, boyle your Salpetre liquor in a Caldron, and scumme it (which scumme reserue) vntill the liquor being proued with a knife, be found ready to congeale; then take off, or else put 8 or 9 times as much Salpetre liquor thereunto, and hauing made the scum rise, and taken it off, and reserue it, let it boyle a fret, vntill the liquor be againe able to congeale: which if it prooue too tender, it is a signe it is no boyled enough; and if it be too hard, then that it is burnt too much. and must for the first be more boyled, and for the latter recouered with more Salpetre liquor, and renew the Worke: but being found indifferently betweene both, take it from the fire, and put it into halfe Tubs, wherein good wood ashes are placed vpon a laying of Strawe vpon faggot, stick, or Lathes in the bottome thereof, and let the liquor drayne through the same, and put it into coolers, or brasse shallow pannes to congeale, and let it stand in a coole roome, where in two or 3 dayes it will shoote out like yce sickles, and keepe that for Roch Petre, and the liquor that will not congeale, keepe for Mothers, to worke a new for more as before. And this is the order to make Artificiall Salpetre: And the scumme that rose in the boyling, mixed with water, and sprinkled vpon Floores, will exceedingly procreate Salpetre in short time.

To collect Salpetre that naturally breedes on Walls, on Caues, in the Ground, or in Vaults.

GAther the Petre together, and adde thereto ¼ of quick Lyme and ashes, and put them into a halfe Tub with a hole, to drayne out water, then put in warmed water, and let it so stand, vntill the Petre be dissolued; then let it drayne out at the hole by little and little, and filtre it if neede bee, if it come not cleare enough: and then boyle it vntill it will congeale as aforesaid.

To Refine Salpette wet.

TAke what quantity of Salpetre you please, and put the same into a cleane Caldron and put thereto a little faire water, and boyle them together vntill it raise the scumme, which take off and keepe, and let it congeale and shoote in coolers, as at first it did, and what remaines, boyle againe with more cleare water vntill it congeale.

To know if Salpetre be well refined.

TAke of it, lay it on a boord, and put a coale to it, if it raiſe an Azure ſcum, it is yet greaſie; if it leaue pearles, it is yet earthie: But if it burne into the boord, and leaue nothing but a blacke colour, and riſe with a long flamed ventoſity and exhalation, it is well refined.

Of Gunpowder, and to make the vſuall ſorts thereof.

FOraſmuch as *Powder* is the Baſe and foundation of all Fire-Engins, therefore I will ſhew his preparations. There are ordinarily three ſorts of Powder made, whereof one ſerues for Birding and Fowling, which is quickeſt, being 7 or 8 of Petre, for one of coale and of Brimſtone: The ſecond for Muskets and Piſtolls, called fine Powder, which is 5 or 6 of Petre for one of Coale and one of Brimſtone. The third, called Ordnance Powder, is of 4 or 5 of Petre for one of Coale and ſulpher: But for ſeruice, there is but two namely, Ordnance Powder, and fine Powder. There are infinite receipts for making of Powder, but moſt States haue enioyned a certaine proportion amongſt themſelues, although much different one from another: wherefore no certainty can bee herein generally concluded, but euery man muſt practiſe for his experience: onely a word or two I will ſay thereof, namely, that before the Receipt aſſigned be compounded, it is requiſite for making of good Powder, to refine the Petre, to purge the Sulpher, and to chuſe good coales, made either of Hazle, Alder, Willow, or Birch, Wood without Barke or Knotts therein being well burned. And then to worke thoſe three Materialls well together: for therein conſiſteth a greater difference of force, by the difference in working of them, then is credible without experience. It is to be wrought together by a Horſe-Mill, or Water-Mill, or in a Mortar with Peſtles, the Materialls kept moyſt.

The Compoſitions of Corne-Powder.

FIue pound of Salpetre, one pound of Coales, and one pound of Brimſtone, fiue pound of Salpetre very well refined, as afore is ſhewed, 1 *l.* of Willow, or Alder Coales wel burned, and of Sulpher well purged 12 ounces: Or of ſixe *l.* of Salpetre, Sulpher and Coale of each one *l.* Or of Salpetre 7 *l.* Sulpher prepared with Quickſiluer, as wee haue alſo ſhewed before: Or Floores of Sulpher one pound, & coales of Hazle halfe a *l.* Or if you mingle as much quick Lyme in powder as Sulpher, you ſhall make powder that the moyſture ſhall not impeach taking of fire. Now ſeeing that it will be to little purpoſe to ſhew the Compoſitions, vnleſſe we alſo ſhew the manner of making thereof, which though the varieties both in compoſing and making are many, tending all to one ſame end, we will therefore ſhew one reaſonable way for ſmall quantity. Firſt, put your Compoſition into a braſen Morter, or of wood with a braſſe bottome And take alſo a braſſe peſtle, and beat it ſo well together for the ſpace of ſixe, ſeauen, or eight houres, that in cutting the ſame with a knife, there can none of the Materialls be diſcerned a part, but all well incorporated into one body, alwayes moyſtning the ſame with a little cleare water, ſtrong Vinegar, or Aqua-vitæ, ſo much that the coales duſt not, and ſo little, that the compoſition in working become not paſte.

paſte. But if you would haue your powder very ſubtill, moyſten the ſame with the diſtilled water of the outer rynes of Oranges, and let your ſulpher be cleare. Sulpher vine which in the melting had ¼ of Quickſiluer put therein, and incorporated, finely beaten, and ſearced with coales, quenched with cleare water, wherein quicke lyme hath beene ſlaked, and either let it ſtand to cleare, or elſe be filtered: and this moyſtning will make the cornes thereof become hard, and not yeeld to moyſture ſodainly. After the compoſition is thus well beaten and wrought together (the more the better) take a Syue with a Velome, or Parchment, or Leather bottome, made full of holes, of the bigneſſe you deſire your cornes, and put the Receipt or compoſition therein, with 2 or 3 ſhort Rowlers, a little moyſtening it, that the pouſier or duſt thereof flye not away. And ſifting them vpon a long Rowler, ouer a halfe Tub, ſo will the ſhort Rowlers driuing the compoſition through the holes, make the cornes come out round yet of ſeuerall ſyzes, which to bring to haue all the cornes of one bigneſſe, you muſt paſſe through ſeuerall ſiues, as they vſe to ſyze Hayleſhott: So ſhall your Cornes of euery ſyze bee equall. And looke what in ſearcing and duſting reſts vncorned, muſt bee ſeperated from the reſt, and new moyſtned and beaten, and then againe ſifted as before; whereof ſome duſt called *Pouſier*, will ſtill remaine vncorned, which may ſerue excellent well to make Rockets with. And theſe cornes may be dried in the Sunne, or in a warme place, ſafe from fire. The powder being dried muſt be duſted againe to ſeperate the Pouſier from the cornes. And to the end the powder become not moyſt, it ſhould be kept alſo in a dry warme place, Moyſture and Age being both enemies to powder: Moyſture, by making the Petre deſcend, or elſe vapour, whereby one end of a barrell of powder that hath ſtood long, will be better then the other, and Age by breaking the proportion and incorporating by the Petres growing and encreaſe, and by the coales corrupting together, with the Sulphers decaying by age in quickneſſe to take fire. And ſo both through moyſture and alſo by Age powder will decay. Next it muſt be conſidered whether it be moyſt or dry, or wholly, or but in part decayed, and ſo accordingly to vſe reaſon, with diligence to renue the ſame.

Seuerall wayes to know if Powder be decayed or no, whether by moyſture or age, and are decayed in part.

IT is the reall practick part of a *Gunner*, to know his powder, and whether it be decayed or not by mutation or corruption. And there are eſpecially three ready wayes to finde the ſame. The firſt, is by the ſight; the ſecond, by the feeling: and the third and ſureſt is by firing it. By ſight if it be not blacke and darke, but bright, and enclining to a tawny blewiſh colour. By feeling, graſping it in the fiſt, if it runne through the fingers quickly, and auoydeth the handling, and cling not together. By fire, if fired it riſe quick, and ſpread in a moment, ſmoake little, but riſeth in a cleare flaſh, vnto which adde further, if it leaue no feces but carrie all away, the powder is good, or elſe the contrary is to be iudged.

To reuiue or renew powder, which is in part thereof.

OFten times in Forts, but vſually at Sea powder, cannot be kept ſo farre from humid vapours, but that it decayeth the ſame, and maketh it of little, and ſometimes of no vſe without renewing it. And ſometimes it may decay by age as we haue ſaid. Let therefore the Gunner firſt proue the powder by fire, and if it make a flame with a long tayle, that is, if it ſleepe in its burning more or leſſe, then for euery 100 *l.* aſide 4 *l.* or 6 *l.* as need requires of refined Salpetre thereunto, mixing them well together, and put them to be beat and wrought by the ſpace of 3 houres together, and then moyſting, corning, and drying the ſame as aforeſaid, prouing it in meale dryed, how it will riſe by firing: and ſo doing, the powder may be made ſeruiceable, if the coale be not corrupted.

Another proofe of powder to be renewed, decayed in part.

TAke a pynt, or quart, or any other meaſure of good powder prooued and dryed well: Then take of decayed powder well dryed the like meaſure, and waigh them both, and looke how much the equall meaſure of good powder waighed more then the decayed powder, adde ſo much Salpetre refined, as the difference of their waights was vnto euery time, ſo much of the decayed powder, and moyſten, beate corne, and dry it aforeſaid, and it may being proued, be found ſeruiceable and good powder: for the Salpetre onely waſteth by diſſolution, which neither the coale nor brimſton doth, wherefore by the rule of 3, you may finde how much Petre any aſſigned quantity of decayed powder, will require to renew the ſame.

To renew powder totally decayed.

BVt if the powder bee wholly decayed, lay a Rayſin frayle or Matt in a bottome topped, bucking Tubb vpon Fagots or Lath, ſet on edge, to keepe the Matt from the bottome, and put in ſtraw, layed croſſe-wiſe, vpon which powre the decayed powder, then warme water and put thereon, and let it ſtand and ſoke 10 or 12 houres, that all the Salpetre may be aſſuredly diſſolued, then let out the liquor at the bottome top, which filter and congeale into Petre, and adde thereto a due proportion of coales and Sulpher, and make it into powder as is formerly taught: For the coales and Sulpher diſſoluing, will remaine behinde in the Straw, Frayle, or Matt: Or elſe if you put the decayed powder in a bagge, and boyle, or ſoke it in warme water, the Petre will ſoke out, but ſome will bee ſoked into the c oath of the bagge, and with more labour muſt be ſoked out.

Another manner to renew powder without new making it.

TAke 3 *l.* of the decayed powder, and diuide it into 3 equall parts, which ſpread thinne vpon 3 Tables or ſmooth boords. Then diſſolue one ounce of refined Salpetre in a little warme water by it ſelfe, and with a hayre ouerſprinkle it vpon one of the third parts. Likewiſe diſſolue 2 *z.* and ſprinkle it vpon one other of the third parts. And laſtly, ſo diſſolue 3 ounces of Salpetre, and ſprinkle vpon the third part of the 3 *l.* of decayed powder. Then dry the ſaid 3 parts or pounds of powder ſeuerally, and proue by fire whether

ther that which had 1 ℥, or that which had 3 ℥. of Salpetre ſprinkled vpon it is beſt, you may thereby know how much Salpetre will renew all the whole quantity of decayed powder in the ſame manner, without new making the ſame.

To make powder that ſhall not decay with time.

TAke what quantity of powder you will, and mixe it well with Aqua-vitæ, and make it vp in Balles, and dry them well in the Sunne, or in a watme place, and keepe them in an earthen pot well glazed, vntill you haue cauſe to vſe them. *Cateneo* ſaith, this powder will neither decay, nor waſte by age.

CHAP. LXXIII.

Of the making of ordinary and extraordinary Matches, to giue fire with vnto Ordnance, or Artificiall Fire-workes, and ſuch like.

TAke Ropes made of Towe, about the bigneſſe of a Mans little finger, being twiſted looſely, and Taw and beate them with a Mallet vpon a ſtone, till they be ſoft and opening: Then put them into a Caldron full of ſtrong Lee, made with aſhes and quick Lyme, wherein alſo a quantity of Salpetre or Mothers being put, and when they haue boyled well ⅞ of the liquour of the Lee conſumed. Then draw out the Match, and twiſt it harder while it is moyſt, and afterward dry it vpon Lynes, but firſt draw them through a hole, as Wyre-drawers doe their Wyre to make it euen.

To make extraordinary Match of Cotton, Tarne made Bobbin-wiſe, of a finger thickneſſe.

TAke as many threds of groſſe Cotton yarne, that hath not taken Salt-water by transportation or other ill Accident, and worke them Bobbin-wiſe of a competent bigneſſe, and boyle them in Salpetre-water, and ſqueeſe them, and rowle them on a Table, whereon Mealed-Petre, and Sulpher is ſpread, then draw them through the palme of your hand, and then dry them well.

To make Match that will reſiſt fire and water.

TAke Salpetre refined one part Sulpher ½ part, and put them into a Pot with ½ part of Camphere mealed with the Sulpher, and one part of fine mealed quick Lyme, with ſo much Lynſeed oyle, oyle of Petre, a little Verniſh liquid, to temper them well together. Then take of Cotton bobbin Match as bigge as your little finger, and put it into the mixture to ſoke ouer a fire, vntill it be well imbybed, and haue ſoked vp the liquor. Then take

the Feces or remainder, and put them in the palme of your left hand, and with your right draw the Match through it twice or thrice, claſping cloſe your fiſt, that the Match may receiue the ſubſtance of it thereinto. Then dry it vpon a line, and keepe it for ſpeciall vſes, for Vaults, Mynes, and moyſt weather.

To make a very violent Match.

TAke two ounces of Powder, 4 z. of Petre, two ounces of Aqua vitæ, diſſolue them ouer fire, and put in your Cotton Match, to ſoke it vp: if you imbibe the Ficelles for your Rockets therein, it will bee very proper, you may rowle and rub them in Meale Powder vpon a Table, dry them and keepe them in a dry place, which let ſuffice at this time.

OF

OF ARTIFICIALL FIREWORKES FOR Tryumph and Seruice.

ALthough Gunpowder with the ſoule Petre, and the life Sulpher, and the body thereof Coale, be indeed, the chiefe baſes and foundations vpon which the practiſe of Artillery, and making of all artificiall Fireworkes, either for ſeruice in the Warres, or for Triumph after Victory, or for delight and pleaſure dependeth, whereof wee haue already ſpoken ſufficiently: yet Fire being the Primarie cauſe for performing their ſequent effects, we will firſt briefly define what Fire is, and then ſhew who were the inuenters of it, according as Antiquity hath diuerſly left vs their Teſtimonie. Fire is an element hot and dry, the moſt rare light and pierſing, either detayned here below by Art, or conſtrained by Accident: It ingenders and feedes vpon that, which by Nature it alwayes affecteth and it ſtriueth to get aloft, as vnto the naturall place and repoſe thereof, as our firſt Theorem plainly manifeſteth.

The Poets fained, that *Promethius* firſt ſtole the Fire from Heauen: But *Vitruuius* ſaith, it was accidently found, and happened by the violent agitation of the Windes and Tempeſt, among the Armes and Branches of Trees, robuſtly rubbing one againſt another, which made them kindle fire & burne. *Plynie* ſaid, that it was found by Souldiers, becauſe they vſually giue violent ſtrokes vpon ſolid things, oft times ſtriking ſparkes of fire. *Lucretius* ſaid, it was ingendred from the lightning, and that *Vulcan* the King of Egypt, was the firſt that perceiued that fire to make vſe of it amongſt humane creatures, wherfore the making of *Ioues* Thunderbolts was attributed to him. And *Or-*

pheus making little or no diſtinction betweene *Vulcan* and fire, in his Himne ſingeth.

Braue valiant Vulcans *liuing flames on earth remaine as yet,*
where in bright ſhining firie Roabes his Maieſtie doth ſit, &c.

Fire being alſo a thing neceſſary for mans life, conſiſting of heate and humidity, ſimbolizeth generation ſo neerely, that ſage Antiquity therefore faigne the marriage betweene *Vulcan* and *Venus*, and attribute the cariage of Nuptiall Torches vnto him, at ſuch times as the Louers would embrace each other. Many more were the ancient fictions & opinions concerning this element of fire: but thoſe I leaue for breuities ſake, concluding it as I begun, Fire to be a more rare, ſubtle, and light element of Nature, then the ayre which is but his Nurſe, ſeeing that if ayre become compact, and fixed in a ſtraight place, and fire chance to burne ſuch an Ayeric body, that would either eate or drinke, or conſume it, and thereby leaue the place voyd, which nature abhorreth, as appeareth by our 4 or 5 *Theorems*, or elſe that rarifieth and encreaſeth the body thereof by the third and *6 Theorem*, and ſo 2 bodies ſhould be in one place contraty to the 7 Theorem hereof; which let ſuffice, and ſo I will proceede to the matter, for contriuing and compoſing of ſome Fire-workes, both for Seruice and Triumph, and conclude this Treatiſe for this time.

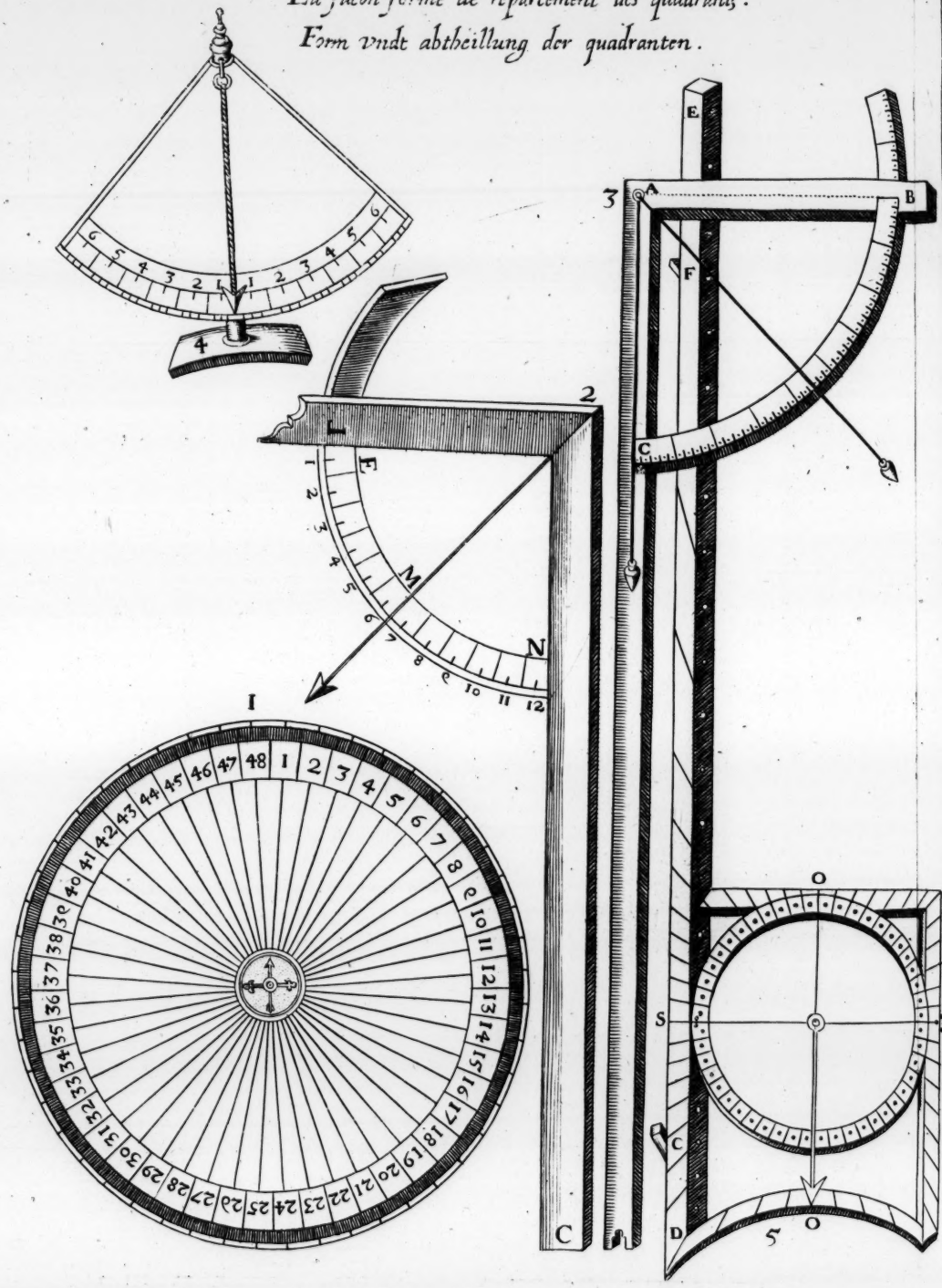
Of Rockets and their ſtructures.

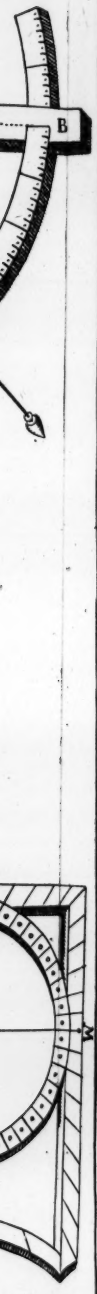
HAuing hitherto ſhewed the Gunner how to apply Artificiall Fire-workes in the Warres, referring their ſeuerall compoſings hither, as alſo the manner of making Fire-workes for Triumphes and pleaſure, wherein I will begin with the making of *Rockets* in the due conſtruction and application, whereof conſiſteth all the pleaſure of Motions of Fire-works: For the making of Rockets there are many things neceſſary, as the Mould The Drifts & paper or Parchment (for paper or Parchment Rockets double and well paſted, or glewed) Pryming Pearcers, Rodds, Morters, Searcers, Mallets, and diuers Receipts and Compoſitions of the Materials, wherewith they are loaded or made. Therefore it will not bee amiſſe to ſhew the reaſons, formes, and proportions, as well of the Moulds for Paper and Parchment Rockets, as alſo the Mixture, Receipt, and Compoſition, whereof they and the Cane and bored Rockets, according to the ſyze of their grandures, are to be made. Firſt, vpon a Paper you ſhould know how to trace or draw the figure of the Mould, according to the bigneſſe you would haue your Rocket, that your Turner may vnderſtand how to make them. To doe which, make a right lyne vpon a paper, and take with your Compaſſes the breadth & height of the Rocket you intend to make, and with that diſtance, ſet ſixe of them along in the ſaid lyne, as from the point *A*, to the point *B*, with the Tayle and all, next the vent or mouth thereof, or rather 6 and ½ of thoſe

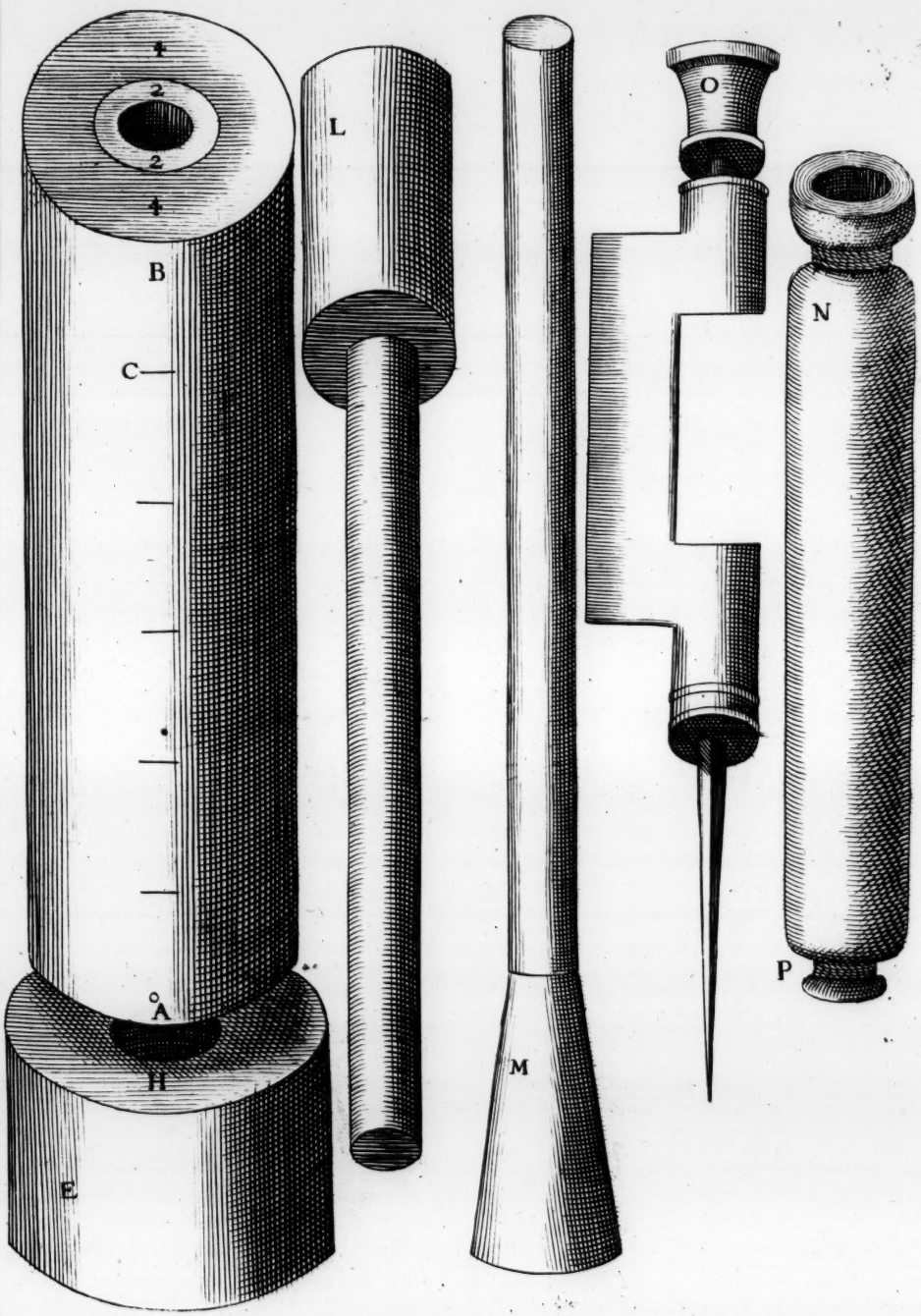
Tractat. 3. cap. 13 fig. 1

La facon forme de repartement des quadrants.

Form vndt abtheillung der quadranten.




B
M


4
2
2
4
B
C
A
H
E
L
M
O
N
P

those ouertures or heights. The wood of the Mould must be inuirond about the Soule, or concaue Cillinder thereof, & also as thick as it, in such sort, that the Calibre thereof be full 3 diametres. And the Soule or Concaue of the Paper to abate ½ in circumference for his thicknes, as may be seene in the 21 figure at β. So *A B* is the length of the Mould, and *B C* is the dyametre thereof: the figures of 4 shew the thickneſſe of the wood on each side, and 2 the thickneſſe of the paper. The foote shall haue the thickneſſe or diametre of the Mould, and be at 1 and ½ thereof in height, with a head lessening to fit the vent, with a Pearcer, ioyned to the foote and body of the Mould, and is to bee screwed, or let in that with a doue tayle, that they may bee firmely fastened together, as *A* to *E*. The Drifts must bee of the full length of the Mould, and very little lower then the dyametre of the Soule of the Paper, the one represented at *L*, and the other at *M*, and that which is for the driuing the powder, *M* must be the thickneſſe of one rowling of paper, lesse and longer then the other *L*, that is for the former to rowle the paper vpon, that it may enter in and goe out, to driue the powder and mixture close home, being filled by a little and little at once, and then driuen.

So then the Rocket *N* will be 10 Calibres, 9 for the powder, and 1 for the bindings aboue, & the bond and fucill below. And the Pearcer *O* must be at least ½ of the length of the *Rocket*, whereof by the figure you may see both the forme and proportion. And also although some would haue a pin reach so high from the breech of the *Rocket*, and of the Drifts fitted with a hollowneſſe to receiue it in the driuing: yet that fashion being very vncertaine and requiring much skill, handineſſe, and practised experience, to bring it to rise well, I haue rather left it to be pearced after the driuing.

For the Receipts, they must be according to their grandures, & to be filled by a little and a little at once, and giuing 4 or 5 strokes vpon the Drift with a waighty Mallet, continuing so vntill it be full within a finger or twos breadth of the top, and it must bee made of strong paper or parchment well rowled about the Former, or else it will be worth nothing. and besides, if it be not also well pearced and pryned, it will neuer rise well. If the Receipt for small Rockets should be filled into great, the mixture would be too violent, for that experience teacheth that, fire being giuen to a composition in a large amplitude, and burning a great quantity, in a little space it holdeth not proportion with the little. For the Rockets of one or two ounces of Receipt, they may bee of the composition following. Either take fine or Harquebuze powder one pound, and soft wood coales two ounces: or one pound of fine powder, and another pound of Cannon powder: or take one pound of fine powder, and an ounce ½ of Salpetre, and 1 ℥. and a halfe of coale. *For one or 2 ounces Rockets.*

For Rockets of 4 *z*, and for Serpents in quills take 4 *l.* of powder, 1 *l.* of Salpetre, and 4 ℥ of coales, and sometimes ½ ounces of Sulpher may bee added thereunto: or take powder 1 *l.* 2 ounces, and ½ *l.* of Salpetre, 4 ounces and ½ of coales: or experienced, take powder 1 *l*, Salpetre 4 ounces, and 1 ounce of coales. *For 3 or 4 z. Rocket, and for Serpents.*

For 6 ounces take 2 *l.* 5 ounces of powder, Salpetre ½ *l*, Coales 6 ounces, Sulpher and Limmell of Iron of each 2 ounces. *For 6 ounces Rockets.*

Take for 8 ounces 16 ounces of powder, 4 ounces of Salpetre, and 3 ounces of Sulpher, with 1 ounce of Coale. *For 8 ounces Rockets or 10 Rockets.*

For 1 l. Rockets. Take 2 pound of powder, 5 ounces of Salpetre, 5 ounces of Coales, Sulpher and scales of Iron of each 3 ounces: Or take 1 pound of powder, 3 ounces of Coales, and 1 ounce of Sulpher.

For 2 l Rockets. Take Salpetre 12 ounces, powder 20 ounces sift, wood Coales 3 ounces, Scales of yron 2 ounces, and Sulpher 1 ounce.

For 3 l. Rockets. Take Salpetre 30 ounces, Coales 11 ounces, Sulpher 7 ounces ½.

Take 30 *l.* of Salpetre, 10 *l.* of Coales, 4 *l.* ½ of Sulpher.

For 4,5,6, or 7 l. Rockets. Take 8 *l.* of Salpetre, 2 *l.* of Coales and 12 ounces, Sulpher 1 *l.* ½.

For 8,9, and 10 l. Rockets. For in the great Rockets you must put no powder, for the reasons aforementioned, as also for that powder, having bin long time mealed and dry, it fortifieth it selfe, and groweth too violent. But if you will at euery third or 4 driuing, dip the end of your Drift in oyle, of Petre or Linseed oyle boyled to the height to scald a feather, you may keepe such Rockets long good. The great Rockets are to bee made of the weaker or slower Receipts. And the simples must be well beaten and sifted in a Searce, and well wrought together to incorporate.

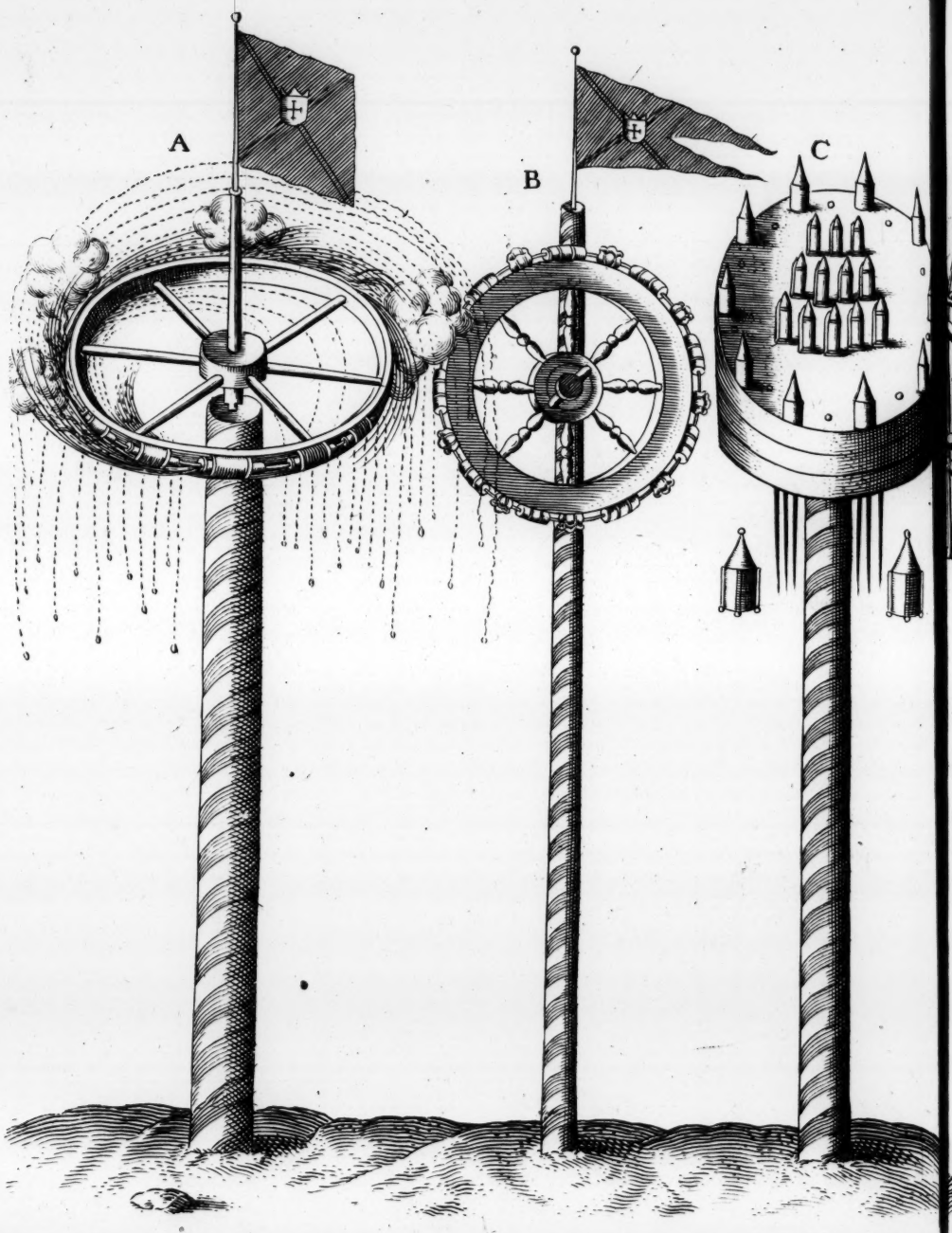
For Breaks. After the Rocket is filled within two fingets breadth of the top, you may fold 5 or 6 double paper, and pierce it through, and make a Pettard or Breaker therein of an empty Walnut shell or 2 filld with powder, or a coffined Cap rather of tinned yron Plate, which will giue the better report, & pierce the Ayre swifter, in which you may else put in 2 or 3 Starre made of Cotton bumbast, put in Aqua-vitæ wherein Camphere hath beene dissolued, and sprinkled ouer with Sulpher Viue. The Rocket being thus made, you must binde vnto it a Rod that must equibalance it, if it be placed vpon your Thumb 2 or 3 dyametres from the Rocket, and it should be 6 7, or 8 times the length of the Rocket, and straight, to cond the Rocket as right through the Ayre as may be: And euer remember to proue some of your Rockets before you goe to performe any shew, and also at the first making that if the Receipt be too strong or too quick, it may be in time slowed with Oyle or Coale: if to slow, with powder or Petre, quickned according to the rising, burning, and arch it maketh.

For Flyers.

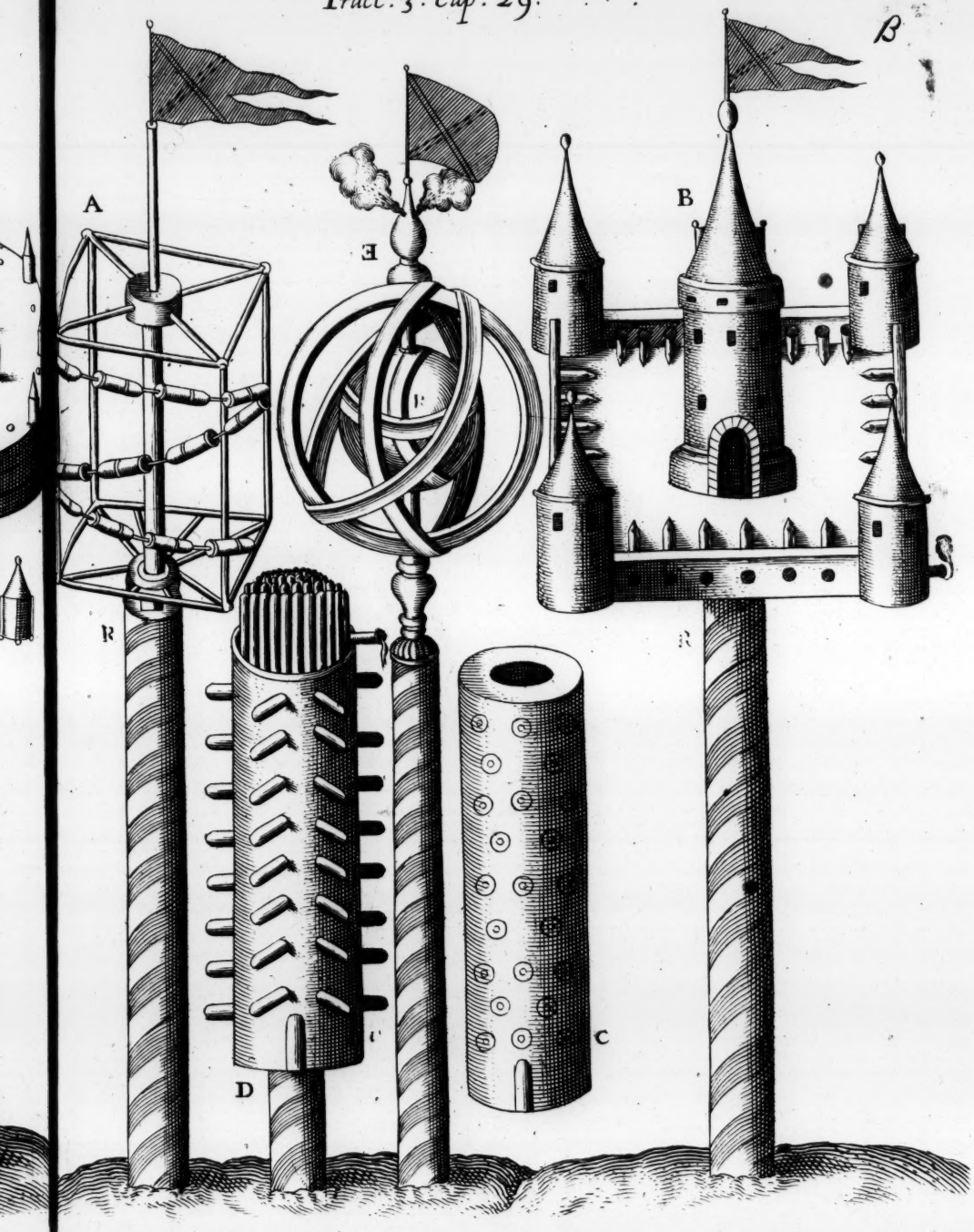
For Runners Those Rockets that runne on lynes also, ought to be very carefully made, whether they are to double, or single, or those that carie Draggons, Men, Shipps, or other shapes in Motion, least they shame their Master. The lyne must therefore be fine, euen, and strong, and being annoynted with soft Sope, it will be slippery, and not easily take fire. And these as well as those that turne wheeles, may haue a further addition of Roch Petre in their receipt, to adde pleasure and life to the Aspect, which let suffice for Rockets.

CHAP.

16
DEC


A
B
C

26
B



BRITISH MUSEUM
1930
DEC 12

CHAP. LXXIIII.

The Deſcription of certaine Wheeles of Artificiall Fire-Workes, and of their Structures and Compoſitions.

HAuing already ſpoken of Rockets ſufficiently, we will next ſpeake of Fire-Wheeles, which were wont to be the chiefe inuentions vſed at Feaſts and Tryumphes for pleaſure, and which by their Motions yeeld great contentment to the ſpectators, as they were anciently vſed. But now of late by ioyning many Tyres betweene the Rockets that burne, and are moued with variety, the pleaſure is much encreaſed. The Workes may be framed both for verticall, and alſo for Horizontall Mouers, either vpon great woollen ſpinning Wheeles, Coach Wheeles, or other Wheeles, made of purpoſe eaſie to runne round, and the greater the better ſhew, and muſt haue the Perch or Axis whereon they are to turne, fitted vnto the bore of the Naue, which Perch and Wheele ſhould bee annoynted or reueſted with ſome incombuſtible oyle, oyntment, or coating, to guard it from firing, which would confound the aſpect intended in the 2 figure following: the firſt at *A* is to moue Horizontally vpon his Perch. The ſecond wheele *B* moueth vertically vpon an Axis, proceeding out of the ſide of his Perch, their other Structures and Compoſitions may bee both alike, or varied at the Worke-Maſters pleaſure, onely that if the Axis of the ſecond were of yron poliſht, and fitted to the Naue, it would be ſurer from breaking and burning, either of which chances would much diſgrace the Fire-Maſter. To Arme them, furniſh them with as many Rockets faſt bound, and betweene them as many Tyres of coloured Fires, Serpents, breakers, or ſhewers of Gold, as you ſhal think with time betweene them fitted, that the Wheele may moue from the ending of euery Rocket, vntill the beginning of the next, with a Sulpher Match betweene them. And when you haue done ſo, couer them ouer with paynted papers, although they be repreſented naked for the Readers better apprehenſion. Now to make a Wheele or Veſſell that ſhall moue Horizontally, and haue ſtanding Fire-Lanterns mooue round, and flying Rockets mount vp into the Ayre. The formes of the Lantern, and all the reſt may well be conceiued by the ſame figures at *C*, which for the inworkes, may be alſo couered with painted paper, as well to hide as grace the Aſpect by day-light, before it come to be fired.

CHAP.

CHAP. LXXV.

How to make a Rice, and a Caſtle, and a Trunke of Artificiall Fire-workes, of great delight.

THe frame *A* is like vnto *Ryces* that skaynes of ſilke are vſuall wound, and is a pleaſing inuention, being inuironed with Bandrolls of Rockets, with a continued ranke: But yet the halfe of them being turned with their heads the contrary way, when the other halfe haue ſpent themſelues: Then by a ſecret Match on purpoſe they are fired, and ſodainly the motion will be made contrary to the former, the laſt of the firſt halfe being ſpent, it giuing Fire to the firſt of the latter halfe, which immediatly worketh its effect.

The Frame *B* is a Caſtle with 4 Towers and 4 Curtins, and a *Caualaria* or domineering Turret in the midſt: The ſtructure thereof is with a thicke planke or two, ioyned well together of the bigneſſe of the plane or foundation of the bottome of the Caſtle, making a great hole in the midſt into, with the top of the Perch, which beareth all the Frame is to enter. The Towers are to be turned of good and ſtrong Timber, about which a number of auger holes, and gutters, are to be made to put to Breakers and Pettards, and to carie Traynes betweene, to fire the Worke in order, in the midſt of each Tower a ſlowe Match is firſt fired aloft, or an earthen pype filld with ſure and ſlowe receipt, one Tower receiuing fire from another vntill all bee ſpent. The Curtins alſo giuing ſeuerall rounds of Cane Cannons, which being well Armed and loaded, will yeeld a good report: there may be placed *Runners* that ſhall fire each other, and paſſe from Tower to Tower, and Flyers, whoſe Rods may be let downe through the Plankes, the Roofes of the Towers ſhall haue Turrets arched, and Vanes vpon them, with flagge and flagge-ſtaffe.

The figures *C* and *D* is formed as Cilinder *Granado* made of turned Timber, as bigge as you will with a hollow Concaue Cillinder in the midſt from end to end: That a Match or ſlowe receipt may orderly fire the Rockets and Cannons entered into the hole. And if you would iſſue a quantity of Flyers aloft, at once to ſpread and flye euery way, place them declining ſomwhat that way you would haue each flye when fire ſhall be giuen: So ſhall you with a ſmall care and handineſſe giue great variety of content to the ſpectators to your commendations.

CHAP. LXXVII.

How to make flying Dragons and Rockets that will runne vpon a Lyne and returne againe, and of Nocturnall Combates in Fire-workes.

THe burning flying Draggon is ſomewhat buſie in the contriuing Structure and Compoſitions thereof, and he muſt be his Arts-Maſter that can performe the ſame well: Although perfection be not required therein, we will ſhew the eaſieſt manner of Framing and Arming them, and putting them in practiſe, furniſhing each of them with one or two Mayne Rocket of a pound or two of Receipt for that grandure as afore-ſaid, according to the way and waight thereof, which muſt paſſethrough the bore threof, hauing a ſparkling ſtarry flaming Receipt to burne in the Draggons mouth, that being fired when the vent at the Tayle is fired may make the Draggon ſeeme to breath Fire forwards, and voyde Fire backwards alſo: The body thereof being all ouer furniſhed with orderly Tyres of Breakers that at laſt ſhall breake and conſume all the body thereof, which being framed with Ribs of dry light wood, or Whale bone, or Crooked Lane Plates, and couered either with Paper or Muſcouie Glaſſe, coloured like to a Draggon, may ſo repreſent that creature in ſhape: theſe are to haue either a voyde Cane, or elſe certaine ſwiules for a lyne, freely to enter into that ballaſted, it may almoſt equipoyzedly hang, and be yare to runne vpon a lyne. Now at great Tryumphes two of theſe Draggons may bee made to moue oppoſitely vnto the midſt of the lyne, whereas a Globe with Sunne, Moone, Starres, & Clouds, may appeare liuely repreſented, as in the 24 Figure at *y* is ſhewed. The line may be made either of Iron or Braſſe Wyre, or of Whipcord, annoynted with Sope, or ſuch like incombuſtible matter. Theſe Draggons and Globes may be framed with Arches and Circles of thinn Latten, faſtned with ſmall lynes, vntill the Body thereof bee framed to your minde. And then ſet vp her wings as ſhe were flying, ſomewhat ſhaking with ſmall Rackets in them. Alſo in the ſame Figure is a double Rocket, coyned with a vacant Cane, they are placed ones head to the others vent, to the end that when the firſt hath caried the other to the end of the lyne, the other may take fire, and returne to the place where it firſt began his Motion. Alſo it will be a pleaſant ſpectacle to behold, to ſee two men iſſue forth at cõtrary places, armed with ſmall Trunks or Staues, and Targets furniſhed with Artificiall Fireworkes, which putting themſelues amongſt the People, ſhall Combat together in Fire. The Targets being of Plankes, may ſpyrally haue Fires of Breakers and Rockets: And the Trunkes and Staues furniſhed with Cane Armed, Rockets & Pettards, no bigger then a quill, and Armed loaded Nutſhell: Or in ſtead of Staues or Trunkes, they may haue woodden dulled Swords or Curtlaces, furniſhed with Fireworkes, which will be a pleaſant fight.

CHAP. LXXVIII.

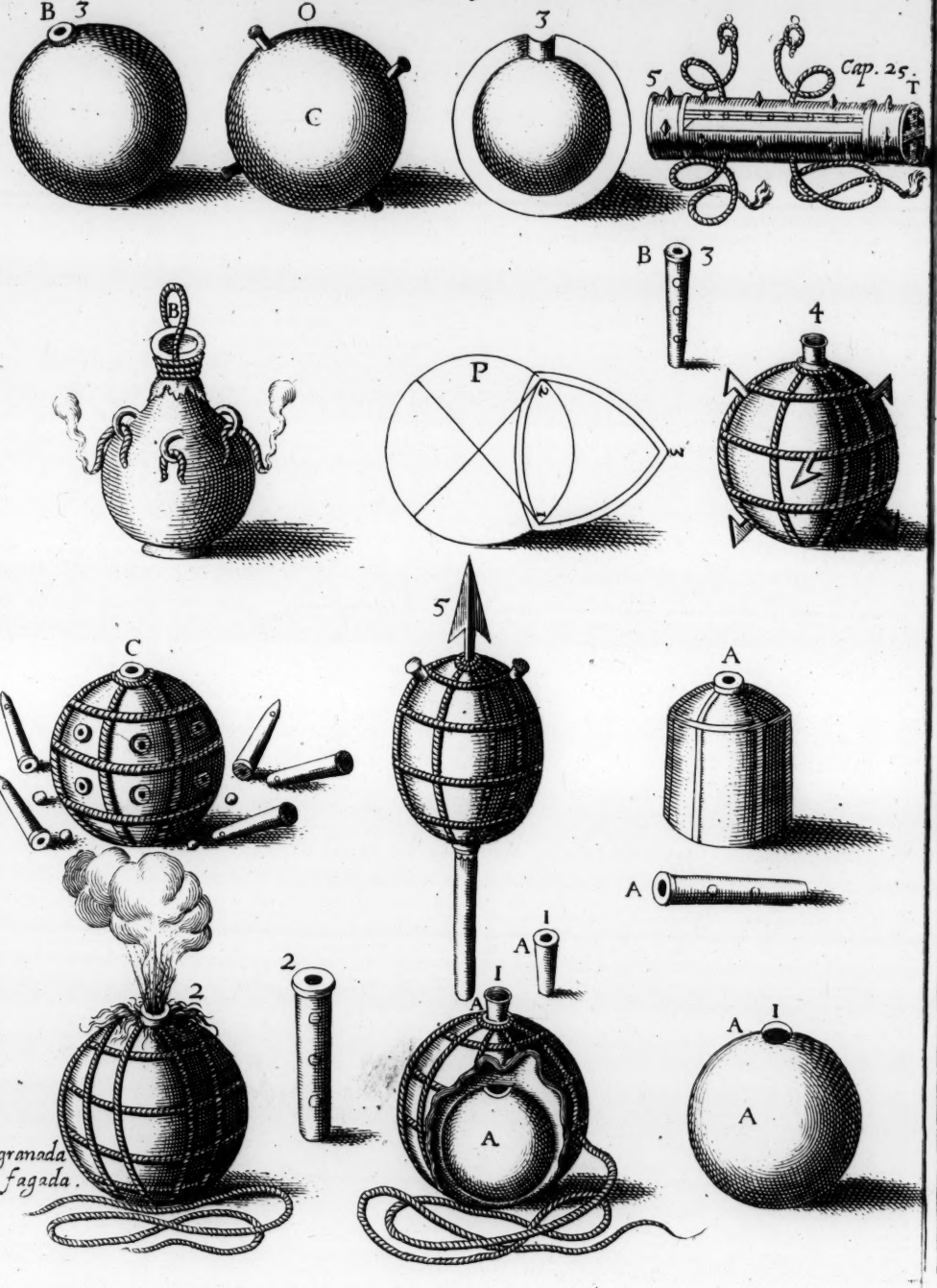
How Artificiall Fireballs and Granadoes are to be formed and loaded with their mixtures.

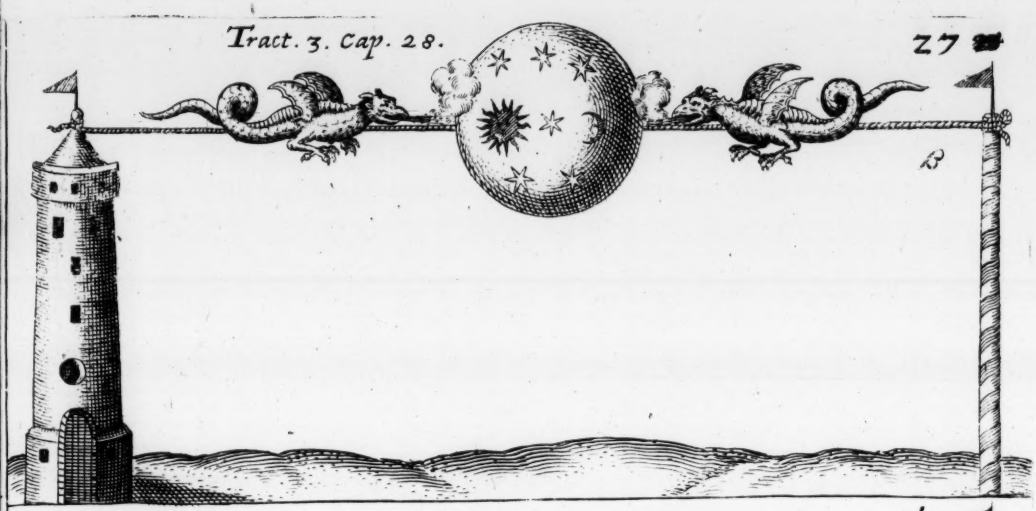
Fireballs and *Granadoes*, are vpon all occasions very offensiue to the Enemie, to vexe and trouble them in their Armie, or besieged in their Hods, or Houses, Tents, or Trenches, Bulwarkes, and Defences. They may bee made round many wayes, according to their Calibre resolued. First, take strong Canuas, and cut out 2 Circles; greater, or more in dyamitre then the Calibre, and hauing turned in the edges of their Peripheries, sowe them strongly with Needle and Thrid round about, onely leauing a little hole, vntill you haue thereby loaded the Receipt, ramming it in very hard, and working it Globally: Or else cutting the Canuas into 8 quarters, as appeareth at *P* in the 27 Figure *a*, or into 4 quarters, with the Compasses as Footballs, with crosse quarters: Otherwise some cut them into 12 panes, as the Globes are cauted in their couering papers, but by their too meny seames they become tedious, and subiect often to open. If you meane to shoote them out of a Mortar or other Peece, you must haue a respect vnto the bore of the Chase, that lopded, and armed, and coated, it may neere fill the Concaue Cillinder. And if you intend to make Balls to sticke, and Fire commonly *Hedgehogges*, you hauing sleight filled your Ball vnto a Marke, must take two crosse sharpe barbed poynted, hardned, or steeled Irons, that must be put in to the Ball, to appeare through on each side, as at 4 therein is represented: Or loading it with Cannon Chambers and Shot as at *C*. These may be prymed and fired before they be put in to the Peece. The Figure *A* representeth inuention of a Lanthorne, or case that with a pryming Pype, firing a quick Receipt at a time lunted, willbreake and blow vp, and teare all neere it fired, yea though it were shot or buried in earth or wall.

The Balls that breake made either of hollow mettall glasse or clay, baked, and nealed, and loaded with quick Receipts and pype, to pryme with slowe receipt for time, are either single or double to breake, are commonly called *Granadoes*. But Fire-pots and Balls to throw out of a mans hand, or with a *Bascula* may be made of Potters Clay baked with *Eares*, vnto which lighted Matches be fastned, and throwing them, to light vpon any hard materiall, when they breake, the Matches lighten the powder, and dispierce the peeces (or Pistoll-shot contriued about them) as at *B* may be seene. Their mixtures may be of Powder, Petre, Sulpher, and Salarmoniak, of each 1 *l*, and 40 ℥. of Campher pounded, and serced, and mixed well together with molten Pitch, Linseed oyle, or oyle of Petre, proue it first by burning: if it be too slowe, adde more powder; and if too quicke, more Oyle or Rozen. The Balls & Pypes *A A* and *I I*, shew how to make double Balls to light a Champion with one, and when it is thought the force past, it breaketh and teareth all neere it: At *B* and *Z* the making and loadings are represented.

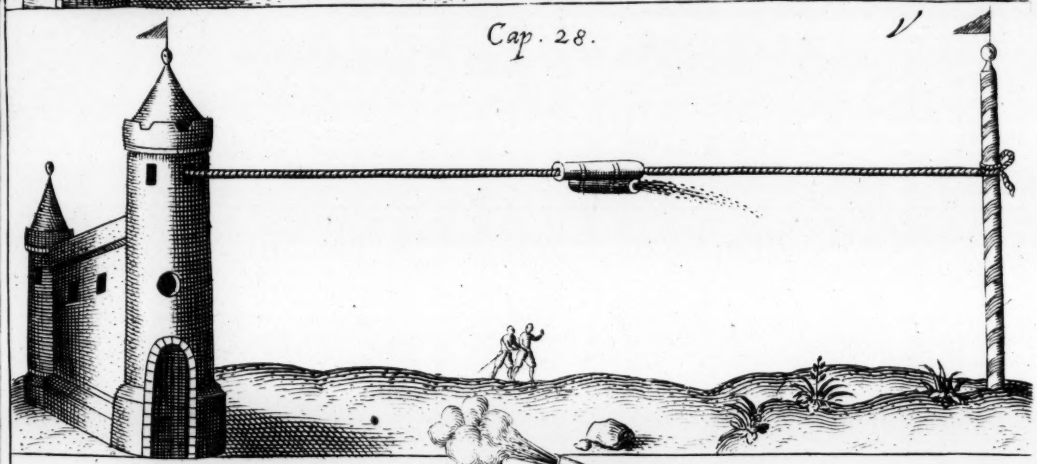
CHAP.

α Tract. 3. cap. 19. et 20. et 21. et 25.

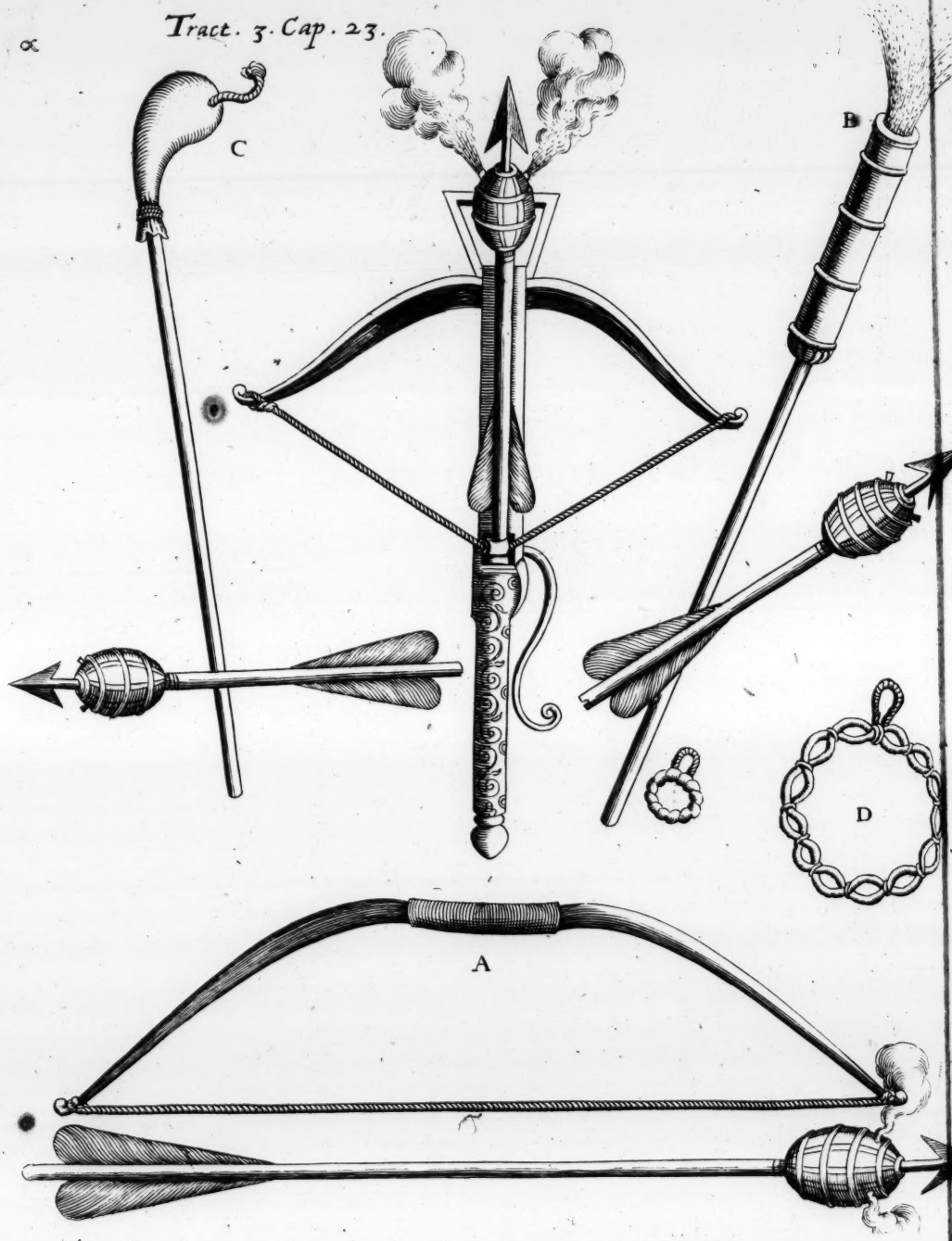


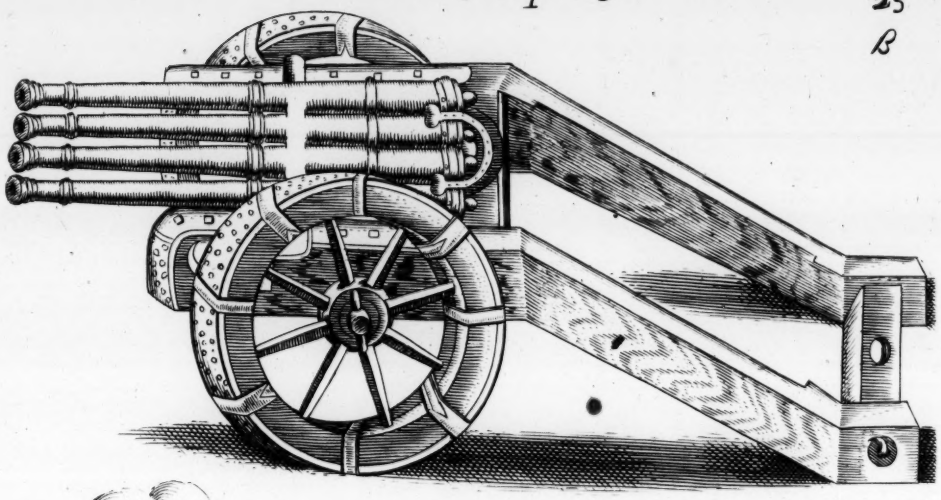


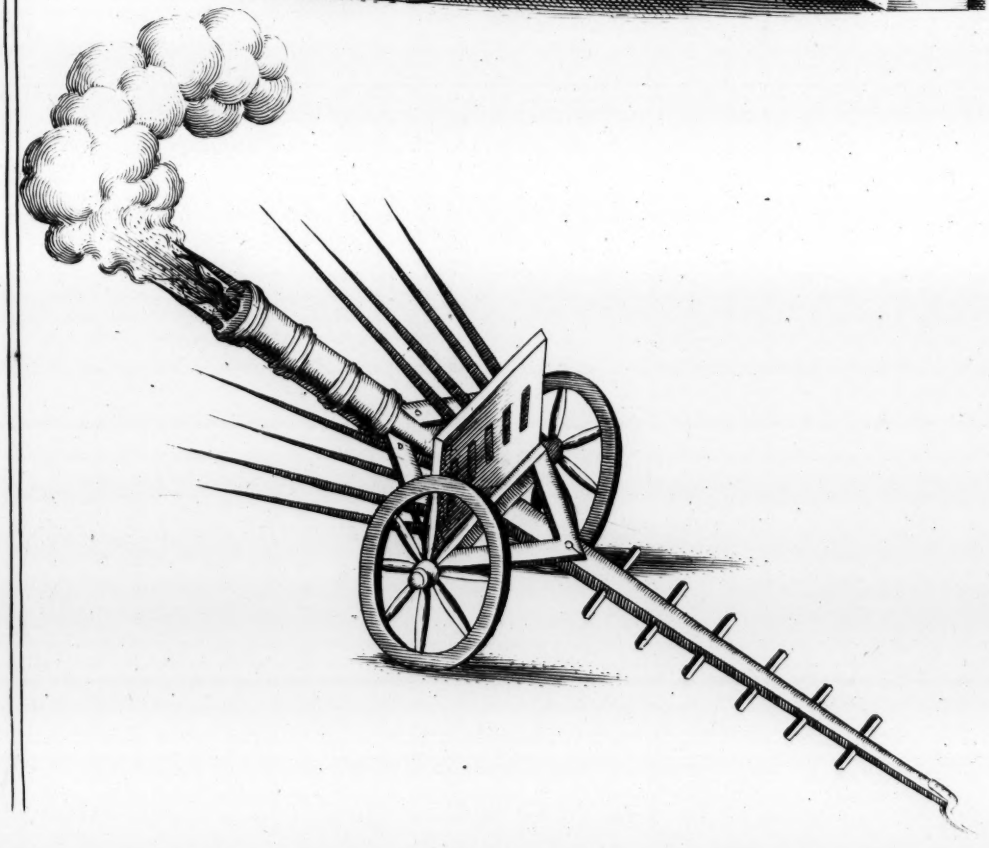
Cap. 28.



Tract. 3. Cap. 30.


C
B
D
A





CHAP. LXXIX.

How to conuoy or direct Fire into a place assigned, or vpon the Enemie in an Assault.

BEeing desirous to fire any Ship, Barque, House, Barne, or other building combustible, the Crosbowe, the *Sturbowe*, with his Rack or Gaste to bend it, represented in the 25 Figure at α, charged with a Fire Arrow fitted therefore, with a Mixture proper thereunto, by the Barbes on the Arrow heads it wil hang where it strikes, and by the vents made of purpose, it will fire whatsoeuer combustible matter shall bee neere it, especially Sayles, dry Timbers, or Pitch and Tarred places: the effect of this Instrument was well experimented at the Siege of *Ostend* and else-where, taking great effect. The like may be done with a long Bowe, but that the Arrow must be longer, as may appeare at *A*. The Trunke *B* will bee necessary for defence of a Breach, or to keepe a narrow passage, or in giuing an Assault, or entring a Ship to keepe all the Defendants before, or in the night sodainly to set vpon Foote or Horse, or in an *Onslaught*. To the same effect is the Pocket, or Bagge *C* filled with fitting Mixtures, whereof wee spake in the last Chapter for resisting the Enemie, assaulting, by sensing or displaying it about on all sides. The Garland *D* being filled and coated with one of the said Mixtures, will do much domage vnto whatsoeuer it lights vpon being combustible. The Arrowes, Darts, and Bagges are to be prymed by Vents, and Armed with Marling, and coated with the Roch fire before mentioned.

But if the *Enemie* be approached to the foote of the wall, and yet couert, in that case, vse the Instrument traced at *T* and *S* in the 27 Figure γ, which is a block of square or round Timber, pearced and loaded with quick Powder, and on the sides round about it hauing holes bored to the Concaue, either to receiue Pistoll shot or 3 square Irons poynted, that being let downe by 2 Ropes from the top of the Wall or Parapet, may by a Snap-hance or Match drawne through a Trayne or Channell of dry powder, Fire the loading within, which by the bores will giue direction to the Shot, to doe the Enemies mischiefe, when other deuises cannot be vsed to repulse them.

CHAP. LXXX.

Of the Pyked Trunke Gunne, and quadruple Barrell-Peeces.

THese latter Peeces represented in the 25 figure at β, are to be accounted amongst the number of *Bastard* Peeces, but are of a new and seruiceable inuention, not only for their lightnes, but also for the great slaughter of the *Enemie* they will make being duly vsed.

The first of them is 4, 5, or 6 Peeces ioyned together, lying like Organ-Pypes placed vpon a broad Cariage, taking fire all at once by meanes of a Gutter or Pype, that conuayeth the trayne of priming powder, from one touch-hole to the next, and all the rest: these are of the proportion of legitimate Culuerings, being 27 Calibres in length of their Chase, and double fortified, being 1 and a halfe in thicknesse at the Calibre of the Bore in Mettall, each carying 1 *l.* of Iron cast shott, with ⅔ of powder, or else 1 *l.* and a halfe of Lead shott, with as much in waight of fine powder: Or they may be loaded with pease leaden or spelter round shott, which will pierce an Armour of proofe 12 score yards off at least, being put in a bagge or Cartrouch for each Peece. And some few of these will send to the Enemie a farre off a continuall vley, or shewre of shot, they are neate and light, for foure of them will not much exceede 2000 *l.* waight, and to keepe a Passage, or defend a Breach, they are of excellent vse.

The second Peece is a Trunke Gunne for fashion, like a Fowler, but close breeched, and is dischurged with any charge: in the Cariage thereof behind there is a thick Elme Planke Musket proofe, with Loopes to the end: their Conducts may be safely couert from Muskets before them: Their wheeles neede not be grosse, and the shaft is with crosse pinnes. Behind in the midst of the Cariage to driue it forward by mens force, in the midst thereof, is a Barrell, like the figure, filled with inextinguished fire, and loaded with Cane, Chamber, with Musket or Caliuer shott, and fine corne powder, and guarded at the Mouth with two Iron or steeled Pykes, and on each side of the Cariage foure long ones fastned, some few of which will exceedingly gall a troope of Horse Charging, and are easily moued; for 2 men with their Muskets are onely needfull, and for their vse, and the structures of them: the figure will sufficiently explane. for their receipt, it may be any sure one with Roch Petre to flame, and scales of Iron to sparkle which vnto Horse by reason of the continuall casting out of Fire, and Flame, and Musket shott, or smaller, will exceedingly affright and gall Horse-Troope, which let it suffice.

BRITISH MUSEUM 10 30 DEC

A Table of Proportions for old Receipts.

For Fire-Pikes 2 Pound weight a peece for one dozen.

Powder 10 *pound.*
Peter Roch 2 *pound and a halfe.*
Peter Meald 2 *lb. and a halfe.*
Sulpher 1 *lb. and a halfe.*
Roſſen 1 *lb. and* 3 *quarters.*
Turpentine halfe a lb.
Linſeed-Oyle halfe a lb.
Som. tot. 19 lb. 4 oz.

For Coating and Arming.

Sulpher 3 *lb.*
Turpentine a quarter of a lb.
Threed 1 *lb. and a halfe.*
Som. tot. 4 lb. 12 oz.

For 2 dozen of Balles, each one lb. 3 quarters Dry worke.

Powder 24 *lb.*
Sulpher 1 *lb. and a halfe.*
Rozen 1 *lb and a halfe.*
Peter Roch 3 *lb. and a halfe.*
Peter meald 1 *lb. and a halfe.*
Som. tot. 32 lb.

For Coating and Arming.

Pitch 2 *ib. and* 3 *quarters.*
Rozen 3 *lb.*
Sulpher 3 *lb.* 3 *quarters.*
Tallow halfe a lb.
Marlin 2 *lb. and a quarter.*
Canuas 3 *quarters of a yeard.*
Som. tot. 10. lb. and a quarter.

For 2 dozen of Balles wet worke of 2 lb. a peece.

Powder 24 *lb.*
Peter Roch 8 *lb.*
Peter meald 6 *lb.*
Pitch 1 *lb.*
Roſen Roch 1 *lb.*
Turpentine 4 *lb and a quarter.*
Linſeed-oyle halfe a lb.
Trayne-oyle halfe a lb.
Som. tot. 45 lb. and a quarter.

For Coating and Arming.

Pitch 7 *lb.*
Rozen 1 *lb.*
Sulpher 4 *lb.*
Canuas 1 *yeard and a halfe.*
Small Marle 3 *lb.*
Som. tot. 15 lb. and a halfe.

For Arrowes 2 dozen each 1 lb.

Powder 12 *lb.*
Sulpher 3 *quarters of a lb.*
Rozen 3 *quarters of a lb.*
Roch Peter halfe a lb.
Peter meald 3 *quarters of a lb.*
Som. tot. 15 lb. 3 quarters.

For Coating.

Sulpher 5 *lb.*
Peter Roch 2 *lb.*
Peter meale 1 *lb.*
1 *Yeard of Canuas and Marlynes.* } 1 *lb.*
Som. tot. 9. lb.

For 1 Dozen of Pots, each one lb. and a quartet.

Corne Powder 1 *lb. and a halfe.*
Ser Powder 9 *lb.*
Sulpher 3 *lb.*
Peter Roch 1 *lb. and a halfe.*
Som. tot. 15. lb.

For Capping.

Canuas 1 *yeard.*
Oeem 1 *a quarter of a lb.*
Sulpher 3 *quarters of a lb.*
Packthred 1 *oz.*
Som. tot. 1 lb. 9 oz.

For Hoopes.

Ser Powder 2 *lb.*
Roch Peter 3 *oz.*
Petre meald 2 *oz.*
Rozen a quarter of a lb.
Sulpher a quarter of a lb.
Turpentine 1 *oz.*
Linſeed-oyle 1 *oz.*
Trane-oyle 1 *oz.*

For Coating.

Pitch 3 *quarters of a lb.*
Rozen a quarter of a lb.
Sulpher 1 *lb.*
Tallow 2 *oz.*

The Authors Len-voy.

Since now my Booke *thou art so farre gone on,*
Abroad on Gods name, and be better knowne:
But had there beene now but one quarter done,
That nor the rest should ne're haue seene the Sunne:
To friends be free, ope them, thy Treasures store,
But carping Scoffers let them haue no more.
But Scraps, for that's enough and good for such
As poyson all they see, foule all they touch:
And on Mechanick scapes forge Arts detraction,
Ere they will winke or mend, which is the faultier Action?
The Errats made, they'le not, did I intend it
For such as not commend, nor can commend it,
Not I, and so I end it.